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THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.*

Second Prize Paper in Engineering News Competition.

By Wm. M. Torrance, M. W. S. E.†

Anyone who contemplates the manufacture of concrete building blocks, or construction by their use, should study the following questions carefully:

1. Proper ingredients entering into concrete for successful work.
2. Forms of blocks. Patent rights and their value.
3. Cost (1) Establishing an industry.
   (2) Cost of product.
   (3) Comparative cost of building of concrete blocks and other materials.
4. Associated industries.
5. Engineering and Architectural considerations.
6. Success so far achieved in the industry.
7. Advantages possessed by an Engineer or Architect over others in handling a successful business.

1. PROPER INGREDIENTS.

Concrete is generally defined as an aggregate of cement with sand and gravel, or with sand and crushed rock, or simply with crushed stone and the crusher dust and screenings from same, mixed with the proper proportion of water to make a material which can be molded into any desired shape while in a fluid, plastic, or semi-plastic state, or only sufficiently damp to pack solid when tamped; and which will "set" in this molded shape without deformation, making an artificial stone.

Contractors and others have often used too little cement, or cement of poor quality, in railroad work or other structures, and the resulting failures and poor appearance have tended to discredit concrete as a building material. In establishing a concrete block business, therefore, no attempt should be made to use any but the best of materials, including the water used, put together in a correct manner and in proper proportions. None but the best quality of Portland cement should be used by a concrete block manufacturer if he wishes to have permanent success.

It is the best practice (in fact, the only correct practice) that concrete should contain somewhat more than enough material of each size of grain to fill the voids in the material of the next larger grain. Thus there should be no less cement than will find the voids in the sand, and no less sand than will fill the voids in the gravel or crushed rock. In many of the so-called "concrete" blocks on the market, only sand and cement can be used, which do not make a "concrete" block in the ordinary use of the term "concrete," but rather a "mortar" block; and this is not so strong or so durable a stone as one to which body has been given by addition of crushed rock or gravel. For any kind of good results with such "sand and cement" blocks, however, more than enough cement must be used to fill the voids of the sand, or the result will be a porous product that will not withstand the elements, as a porous product is bound to result, whatever the method used in making the aggregate; and if too small a proportion of cement is used, actual disintegration is bound to take place within a few years or months. Of course, if the outer exposed face is composed of a mixture which is made in the correct proportions, it would tend to protect a cheaper mixture behind; but large railroad companies and others who have used concrete extensively during a long term of years are practically unanimous in making the whole body of a concrete structure, however thick, of concrete in correct proportions to fill the voids, and it is certain that the best work in concrete must always be so done. If a richer facing mortar is applied, or if the front portion of the block is made richer than the remainder, great care is necessary to see that there is left no plane or joint of cleavage.

Large users of concrete are very strict in their specifications, requiring rigid inspection and tests. The N. Y. C. & H. R. R. R. Co., tests, for instance, are so rigid, that of all the various brands of cement on the market, their inspection bureau now only accepts seven, which are the only ones used in the very extensive concrete work being done by that company. Other large users are fully as exacting. The result is that most of the inferior cement sold is sold to the smaller consumer. He pays on the average a price for cement as high or higher than the large consumer pays, as he takes it in so much smaller lots; and what he gets is very apt to be cement that would not pass rigid tests or fill proper specifications.

Not only the cement but also the other ingredients of the concrete should pass good specifications and tests. Every manufacturer of concrete blocks should be sure that the ingredients are of the best by making proper tests, and, no matter what the provocation, he should never "rob the job" by diminishing the cement below the correct proportion, or by using a poor quality of water, cement, sand, gravel, or crushed rock (the reader is referred to the standard specifications of the U. S. Government, or those of any large railroad company for specifications for good concrete ingredients). This is imperative if the prejudice against concrete blocks is to be overcome. A large proportion of such "concrete" block construction as is now going on in small places throughout the country would, in large cities, be prohibited by the rules of the building departments because of the defective material used, or because the method of mixing is not satisfactory.

Concrete is mixed either "dry," "medium" or "wet." "Dry" concrete is made by use of only so much mixing water as will make it of the consistency of molding sand when being worked. This is then compacted by tamping, as molding sand is tamped.

"Medium" concrete is made by use of enough mixing water so that water will flush to the surface by tamping or pressure.

"Wet" concrete is made by the use of enough mixing water so that the concrete when mixed will pour, or into which, when first deposited, men will sink at least to their ankles.

There have always been strong advocates of all of these processes, but the tendency has been for large users of concrete to change from the

PLATE XIII. THE ROYAL BANK OF CANADA BUILDING, HAVANA, CUBA.
Built by Purdy & Henderson of Concrete Blocks Cast in Sand

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†Assistant Engineer in Charge of Concrete-Steel Design, Hudson Companies, 111 Broadway.

"dry" to the "medium," or to the "wet." This change has been caused by results of many comparative experiments and tests.

Specifications of many companies require "wet" concrete now, where the same companies formerly specified "medium," and it would now be hard to find standard specifications which required a "dry" concrete. Certainly the "wet" and "medium" grades are less porous than the "dry." "Dry" concrete, as made into blocks by many companies, also suffers from lack of gravel or crushed rock, which cannot be used in the process.

The catalogue of one of the larger manufacturers of concrete block machines recommends the following proportions for the mixture of cement and sand to be used in the blocks:

For foundation walls: 1 part cement, 3 parts sand.

For first floor walls: 1 part cement, 4 parts sand.

For second floor walls: 1 part cement, 5 parts sand.

For third floor walls: 1 part cement, 6 parts sand.

It is difficult to reconcile this sort of a recommendation to any sort of reason. The voids in an average sand are not less than about 30%. Therefore, in the 1:3 mixture, the voids will probably be well filled, and a compact, waterproof (or practically waterproof) concrete might result with proper workmanship, but with the 1:6 mixture, probably only a little over 50% of the voids are filled. Blocks so made will be sure to absorb and hold a great deal of moisture, and buildings made of them will be damp. Such blocks will also disintegrate easily through the action of frost.

Although concrete made of ingredients aggregated in the correct proportion may be nearly waterproof, no concrete as ordinarily made will be entirely so. On this account, there are in use many materials or devices for making concrete impervious to moisture. One firm handles a sort of jelly which is used in proportion of one part of jelly to five parts of the cement used. This is mixed in with the other ingredients of the concrete or in the facing mortar. Another firm handles a "waterproof compound" which it "puts up in paper sacks of 40 pounds each, and which is to be used with from fifty to one hundred times its weight of cement." This firm advertises that "cement with one per cent. of the waterproof compound, with five parts sand gives a more impervious mortar than ordinary untreated cement with two parts sand." Another firm, of international reputation, advertises the use of a "stone liquid" for coating brick work, stone masonry work, or concrete. This is applied as a paint, the surface absorbing the liquid, which becomes an insoluble compound, filling the pores in the facing of the wall.

Another waterproofing device for concrete is to use 1% by weight of alum with the sand and cement and 1% of soft soap with the mixing water. The chemical action set up makes an insoluble compound which practically fills all pores, making an impervious concrete.

The above are only a few of many processes employed. The reader is referred to the advertising pages of engineering or scientific journals for names of dealers in waterproofing materials, with suggestions that literature from these firms be obtained and carefully studied.

No waterproofing scheme, however, will strengthen the concrete, and many methods for waterproofing damage the cement, and this makes the concrete less durable. Certainly, a 1:5 concrete, waterproofed, is not so good and durable as the 1:2 concrete, which it is said to equal in moisture resisting quality.

It is probable, however, that waterproofing may often be wisely done on the face of concrete (or incorporated in the whole body of concrete, or at least in the facing mortar of same), whether made in correct proportions or not. It can also be used wisely in the cement mortar that is used in laying up concrete blocks. In hollow concrete walls made by blocks of two-piece section this can be made to prevent water or frost working through, even though the blocks should be made of a porous mixture.

Blocks may be colored very economically and

No. 80,358. PATENTED JULY 28, 1868.

T. J. LOWRY.

MOLD FOR BUILDING BLOCKS.

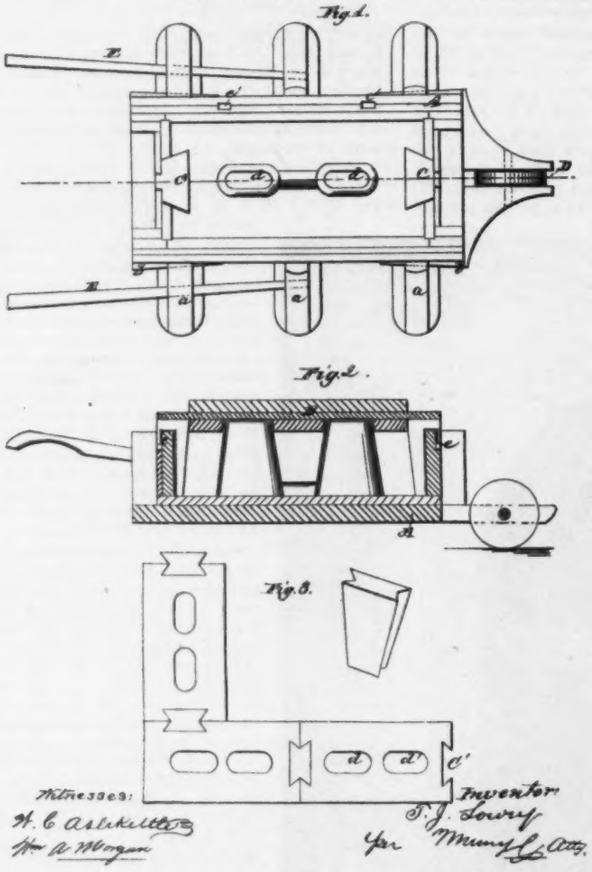


Plate I. Lowry's Patent Mold for Building Blocks, 1850.

T. B. RHODES.

Building-Blocks.

No. 149,678. Patented April 14, 1874

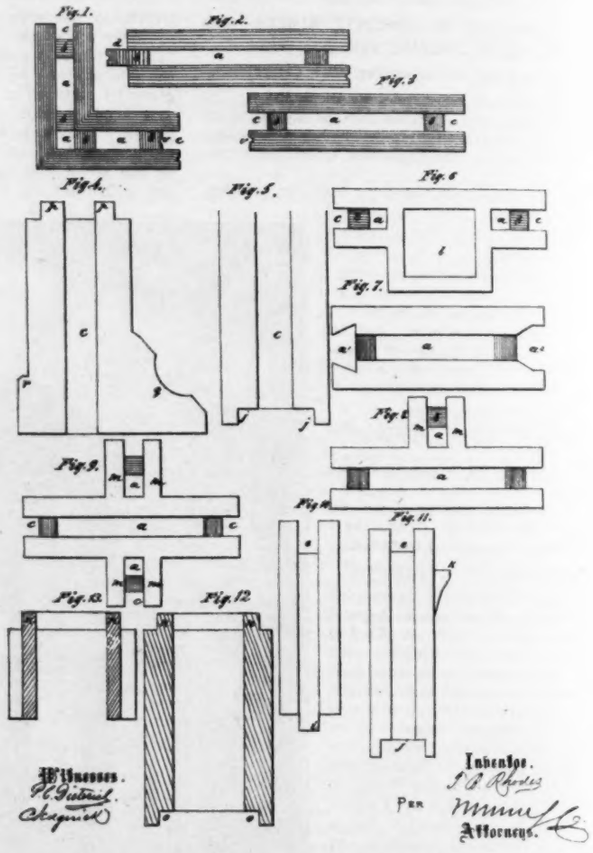


Plate II. Rhodes' Building Block Patent, 1874.

2. FORMS OF BLOCKS. PATENT RIGHTS AND THEIR VALUE.

When concrete first came into general use, it was probably used mostly in making large blocks, at convenient places, to be used, after becoming thoroughly set, in building large sea walls and other heavy masonry structures. The idea of molding a monolithic wall was a later development. The idea of making a wall hollow for the sake of economy, or for prevention of moisture or frost working through was a still later development. At the present time, practically all concrete block manufacture is designed for making a wall with hollow blocks, with continuous air

No. 674,874. **H. S. PALMER.**

CONCRETE WALL FOR BUILDING.

(No Model.) *(Application filed Mar. 21, 1900.)*

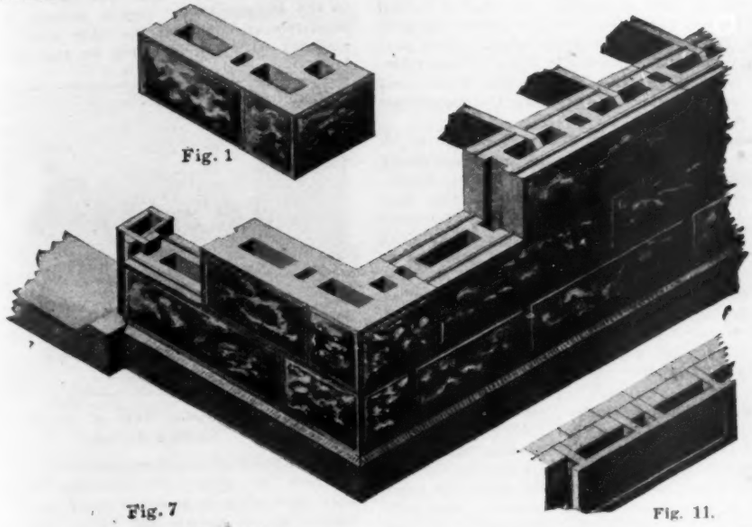


Fig. 7

Fig. 11.

Fig. 1

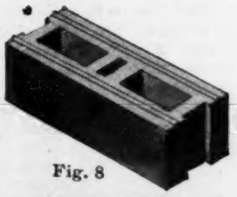


Fig. 8

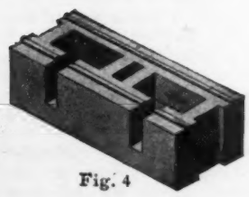


Fig. 4

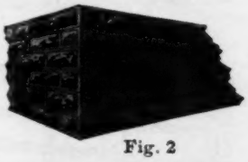


Fig. 2

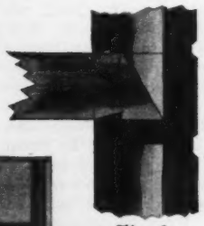


Fig. 6

Fig. 5

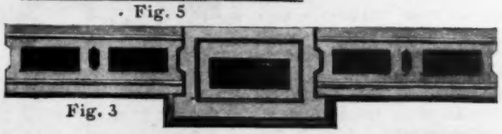


Fig. 3

Fig. 10

Fig. 9

Witnesses:
W. C. COILIES.
WM. GEIGER.

Inventor:
HARMON S. PALMER

PLATE III. PALMER PATENT OF 1900.

chambers in the wall, or by making blocks which, though perhaps not themselves hollow, will lay up into a hollow wall.

The steps leading up to the present state of the industry were all patented by their inventors, and the man who desires to go into a concrete building block business will do well to look thoroughly into the patent rights question. Many of these patents bear recent dates, and their holders sell local county or city rights—transferring such rights for so much money—and guaranteeing the exclusive right to manufacture such a block or such a wall in the territory in question. It is certain that many such patent rights are good merely for the machine employed to make the block, and are not broad enough to cover the block of the form made by the machine, or the wall made of the blocks. Anyone purchasing patent rights should bear in mind that patents are not always upheld by law courts; therefore, he should use ordinary business caution to see that the selling company's guarantee is good.

On November 17, 1850, Joseph Gibbs was granted Patent No. 13,071 by the British Government on several improvements in the manufacture of cement and concrete. His patent included the method, now so common, of building solid concrete walls by means of timber forms or lattices on either side. The specification continues:

> When it is thought advisable to dispense with the lattices and to make the wall without any part of it being composed of wood, then in such cases, blocks of the size of the stone of which the wall would be composed under ordinary circumstances are to be cast, only these blocks are to be hollow, having only sides and ends, the sides and ends being made about two inches thick. After every course of these blocks have been built, the hollows must be filled with concrete like that before described. The blocks being made to break joints with each other, and being filled with cementitious matter, the wall will become one mass of solid artificial stone so there will be no necessity to put mortar between the blocks to bed them. Instead of the blocks being cast in the shape of hollow parallelograms they may have merely a back and face, such back and face being held together by only as much cement or other material as will keep such back and face in parallelism with each other during the time they are setting (after which the filling must be the same as before). It will be well to wet the blocks before concreting cement is put in, so that they may all unite to form a solid mass of artificial stone.
>
> Having described the second part of my invention, I declare that what I claim in respect thereof is as follows:
>
> First—
>
> Second—
>
> Third, I claim the process of molding artificial stone by putting plastic materials between lattices or other convenient forms, and also the method of casting hollow parallelograms in cement to be afterwards filled up with concrete for artificial stone.

It is evident from this description that the inventor did not intend to use his invention for hollow walls, but it is certain that many walls were built in England and Scotland by both the systems above described in which the builders did not complete the process, but left the wall hollow; and it seems possible that the granting of this patent (which long ago expired) may be construed as invalidating many more recent patents on hollow blocks and hollow walls.

On July 28, 1868,* Thos. J. Lowry was granted U. S. Patent No. 80,358 on a hollow block and wall, the block being almost the exact shape of those made by use of many of the hollow block machines or processes now in use. Plate I. of this paper shows the drawing which accompanied the patent. This patent, of course, long ago expired.

On April 14, 1874, T. B. Rhodes was granted U. S. Patent No. 149,678 on a great variety of forms of hollow building blocks and hollow shingles, of "concrete or other material, which in its plastic condition may be molded into the required form." Plate II. is one of the three sheets of drawings which accompanied the patent. In this patent, no method of molding the blocks is shown or called for, or even suggested, so that a broad interpretation of the patent would be that it granted Mr. Rhodes the exclusive right to make blocks of these forms by any method of molding then known. It may be noted from the date of this patent that it long ago expired.

The H. S. Palmer Co., of Washington, D. C., appear to claim in their literature the right to control by virtue of their patents the basic principle of hollow concrete building block machines with removable cores and adjustable sides. Their patents also cover certain forms of block. Plate III. shows the drawings accompanying Patent No. 674,874. This patent, and others controlled by the same company, if rightfully granted, are evidently being infringed on by the makers and users of a great many other machines. The makers of these other machines and devices are practically unanimous in their claims that the Palmer patents, as far as the block or wall is concerned, are void, and act up to this belief. Consideration of the patent 80,358† to Mr. T. J. Lowry, of the patent No. 149,678 to T. B. Rhodes, and of the patent granted by the British Government to Joseph Gibbs in 1850, naturally lead one to question which is right, and all parties interested should insist on a speedy determination of the matter.

To illustrate the trouble that is occurring, and may continually occur, attention is called to the Hayden Block Machine. This machine and whole

*Since this article was submitted in this competition the writer has discovered a still earlier patent; viz., No. 53,004, granted March 6, 1866, to C. S. Hutchinson on a hollow building block and wall making continuous vertical air spaces. This block is remarkably similar in many respects to many of the hollow building blocks on the market to-day.

†Also patent No. 53,004 to C. S. Hutchinson.

outfit is sold by its manufacturers† to anyone, anywhere, for a definite sum, enough to net a fair machine shop profit. They are willing to give with this outfit a bond for several thousand dollars if desired guaranteeing the purchaser against any patent troubles. The makers of the

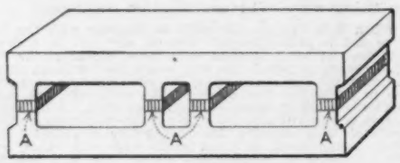


Fig. 1.

Fig. 2.

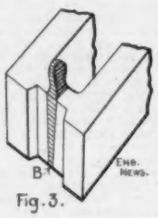


Fig. 3.

Plate IV. Purdy & Henderson's Plan for Making Waterproof Blocks.

Hayden Block Machine emphatically deny that the manufacture of the blocks made on their machine infringes any patent in force. Their machine, however, makes blocks almost precisely of the pattern of the Palmer block, though in its construction it is almost entirely dissimilar to the Palmer machine.

This question is a more serious one, on second thought, from the fact that, if the patent holding company should take the question to court of last resort, and procure a favorable verdict, all blocks, walls, houses, etc., made with other blocks so decided to be infringements might be required to be torn down, or royalty could be collected

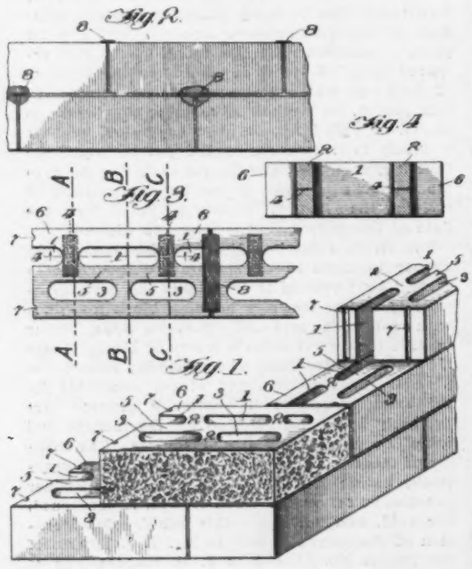
No. 730,780. PATENTED JUNE 9, 1903.

O. U. MIRACLE & W. L. DOW.

BUILDING WALL AND CONCRETE BLOCK FOR SAME.

APPLICATION FILED DEC. 1, 1902.

NO MODEL.



Witnesses:
H. L. Gardner
Fred B. Fischer

Inventors:
Orville U. Miracle
W. L. Dow
by Burton Burton Attorneys

Plate VI. Miracle and Dow Patent of 1903.

from the contractor, or from the owner by the patent holding company.

There are at least two types of block made of width equal to the whole thickness of the wall in which there are no webs that pass directly through the wall; viz., the "Miracle" and the "Blakeslee," both of which are patented. Plates No. VI. and No. VII. show the drawings which accompanied the patents on these forms. These two types, though accomplishing the same purpose, are different in form. One makes a wall with vertical, the other with horizontal air passages. Both of the companies holding these patents have exclusive territorial rights to sell. (Miracle Pressed Stone Co., Minneapolis, Minn., and Blakeslee Concrete Block Machine Co., Columbus, Ohio.)

The first claim in the Blakeslee patent is "A building block wherein there are no continuously solid portions from front to rear." This patent was filed Dec. 19, 1903, and bears the date May 24, 1904, the patent being No. 760,774. The third claim of the "Miracle" patent covers "A building wall consisting of concrete blocks having two rows of air cavities, the cavities of the one row being opposite and being larger than the intervals or necks between the consecutive cavities of the other row," etc. This is patent No. 730,780, filed Dec. 1, 1902, and issued June 9, 1903.

The patent records show that application for a U. S. patent on a multiple air space wall was filed Dec. 4, 1903, by Peter Dierlamm, of Stratford, Canada. This patient, No. 774,835, was granted in November, 1904. The drawing accompanying this patent (Plate VIII.) shows that this patented block is almost exactly the same form as the Miracle block. Application for this patent was filed prior to the application for the Blakeslee patent No. 760,774.

Plate VI., Fig. 3, shows a horizontal section of a portion of a "Miracle" wall. Plate VII., Fig. 10, shows a vertical section of a portion of a "Blakeslee" wall. The writer has added to Fig. 3, Plate VI., three lines marked AA, BB, CC. These lines show how four "Blakeslee" blocks would make one block similar in form to a "Miracle" block turned on end. Practically the same thing would be true of a block of the form patented by Peter Dierlamm.

The "Blakeslee," "Dierlamm," and "Miracle" blocks are improvements on blocks of the "Palmer" type designed to prevent moisture from passing through a wall by doing away with webs passing direct from front to rear. Both the Blakeslee and the Miracle processes use "dry" concrete, the machines being somewhat similar to those used in the Palmer process, which also uses "dry" concrete. Nearly all the competitors of the Palmer Company which makes blocks of forms like or similar to the Palmer blocks also use "dry" concrete. The object gained by using "dry" concrete is rapidity of manufacture, as a block may be removed from the machine as soon as it is tamped and the next block may be started at once, which could not be done by use of "medium" or "wet" concrete.

Purdy & Henderson, of New York City and Havana, Cuba, have recently invented a process which will allow the use of "dry" concrete in blocks made on a machine of the Palmer type, and yet make blocks that will not allow the passage of water or frost from front to rear. Plate IV. shows this improvement, which is described as follows:

Fig. 1 on the accompanying drawing shows the block with the improvement AAAA. It shows the position of the improvement in the webs of a hollow block. If the block were solid the improvement AAAA would be continuous, running longitudinally through the entire block, and if it is desired it is to be used continuously in the solid walls of the hollow concrete building block. The partition or stratum represented by AAAA, in Fig. 1, which is impermeable, may be made of a mixture of cement, fine sand or pulverized stone, or both, and hydrated lime, or other waterproof compositions, such as asphalt.

Fig. 2 shows the wedge-shaped core B which is placed in the openings in the block machine or mold in which the block is to be made. The block is tamped or poured with the wedge-shaped cores in place. When the block is finished on top, the wedge-shaped cores are drawn out and the waterproof mixture, of which the stratum is formed, is poured into the opening, and it becomes homogeneous with the balance of the concrete at once, and the block may be removed as ordinarily and the waterproof stratum or partition will remain in place.

What we claim as new, and what we wish to secure by letters patent is:

First, The wedge-shaped core used in making the opening in the webs or walls of the hollow concrete blocks or of a solid block for the partition or stratum of waterproof mixture.

Second. The partition or stratum of waterproof material in the webs or walls of the block as shown in the drawings. (Signed) Purdy & Henderson, Inc., Inventors.

The inventors are using this process largely in Cuba at the present time and, patent having been applied for, have no competition there. Patent rights on same will no doubt be for sale locally in this country soon.

Plate V. shows a comparative test of two blocks of the Palmer type. One is entirely of "dry," hand-tamped concrete; the other is of the same material with the insertion by the method described above of a wet mixture of broken stone concrete, no other waterproofing being used. Note that moss is growing freely on the upper surface of the unimproved block, while the improved block allowed no moisture to pass up through to the top. At the time this picture was taken both blocks had been resting in the water side by side for eight months.

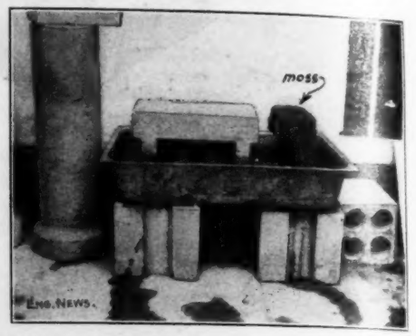


Plate V. Comparative Test of Blocks to Show Relative Porosity.

This test seems to the writer to be as good a proof as one could wish of the much greater value of a "wet" mixture composed of broken stone, sand, and cement, over a "dry" mixture composed of only sand and cement.

There are on the market at present at least three processes of hollow wall construction which do not use the "dry" concrete; viz., by casting "wet" concrete in metal molds; by mixing "medium" concrete and molding same under pressure by machinery; and by casting "wet" concrete in sand. In all these processes gravel or broken stone may be freely used.

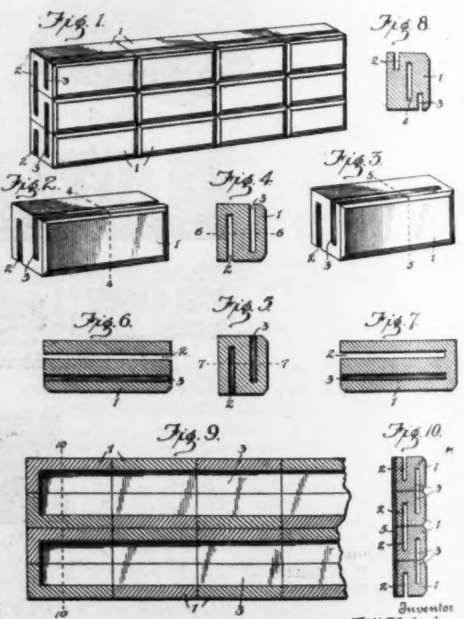
No. 760,774. PATENTED MAY 24, 1904.

F. W. BLAKESLEE.

BUILDING BLOCK.

APPLICATION FILED DEC. 19, 1903.

NO MODEL.



Witnesses:
Helpl. Shepard
Kyle Shepard

Inventor
F. W. Blakeslee
by Shepherd & Parker
Attorneys

Plate VII. Blakeslee Patent of 1904.

†Hayden Automatic Block Machine Co., Columbus, O., and 26 Cortlandt St., N. Y. City.

The process of casting "wet" concrete in metal molds is comparatively cheap, one of the chief items of expense being the great number of metal molds required. These are made with col-

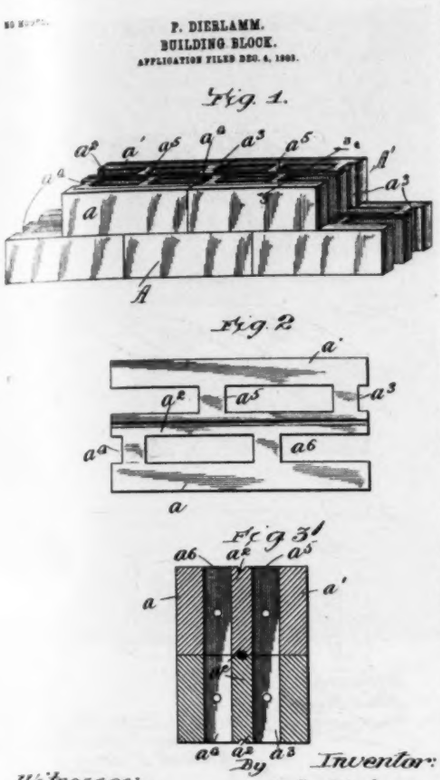


Plate VIII. Dierlamm Patent of 1904.

lapsible core pieces and of hinged joints, so that, after setting, the block may be removed.

Plate IX. shows the drawing which accompanied the original patent No. 704,606, now owned by the American Hydraulic Stone Co., of Denver, Colorado, on its "two-piece" system of hollow wall construction. This company uses in its machinery "medium" concrete compacted by great pressure in the machine. There are numerous advantages to this system over many others now in use, a few of which are here given.

1. The chance to make the wall, and the individual webs of the wall, any thickness desired, by simple adjustments of machinery.

2. The chance to use ¾ in. or 1 in. gravel or broken stone in the aggregate, thus making a true concrete.

3. The patent rights held by this company are very broad, and, if they will hold, they cover almost any conceivable arrangement of blocks of concrete or other material in which the faces are of separate pieces bonded together in the middle of the wall by T, L, or channel projections extending into the middle of the wall.

4. The method of manufacture adopted by the use of the patented machinery of this company allows the use of sufficient water to make a "medium" mixture of concrete. The following claims deserve consideration:

*It is indeed strange, after exhaustive tests on general concrete work have so thoroughly demonstrated the ineffectiveness of a "dry" mixture, that so many should undertake to manufacture concrete blocks without sufficient water to excite such hydraulicity as will secure that thorough crystallization of the silicates of lime and alumina, without which the bonding of the aggregates is imperfect and the concrete easily crumbled. Indeed, it would seem that, eliminating the question of chemical activity, the mere physical problem of combining materials to form the agglomerate should convince the practical man that a "dry" mixture is not feasible, because if the cement be not reduced to a solution it can neither fill the voids nor afford necessary cohesiveness by thoroughly coating the sand and aggregate.

In considering the methods of manufacture, we notice that the system of applying a heavy, uniform, and almost instantaneous pressure is radically different from the customary method of tamping "dry" concrete. It is here that the concrete block manufacturer has a decided advantage over monolithic construction, as the application of a pressure at once adequate and uniform eliminates squashing and sub-pressure, and secures a density and freedom from porosity which a "dry" mixture cannot produce; moreover, the application of such pressure on the face of the block, where the greatest density is required, secures a face practically impervious to moisture and free from the accumulation of soot and dust which has so often rendered cement houses unsightly.

The speed of operation under this system is merely limited by the time taken to fill the molds. As the mold runs into and out of the press on an iron track, and the pressure is made by one downward motion of the levers, the operation requires less than four seconds exclusive of filling the mold. Under ordinary conditions, it has been found that four men operating the press and molds (the mixture being supplied to them) will turn out enough blocks to make one thousand square feet of wall in ten hours; this rate can be materially increased by the arrangement of elevated bins, overhead mixer, chutes and cut-off boxes to feed the molds automatically.

In marked contrast with other systems of block making, this one seems to have been designed with especial view to the application of a rich face at a minimum cost. By striking out a quarter or half inch of the coarse concrete before pressing the block, filling the space thus created with a mixture of suitable fineness and then applying the pressure, the face is so thoroughly incorporated with the body of the block that no line of cleavage remains, and no instance has ever been reported of a face thus applied separating from the main block—it becomes a part of the block itself.

In the construction of walls, the well-known principle of the header bond is employed at intervals of 9 to 12 ins., thus insuring a resistance to thrust and lateral stress which cannot be expected in construction where blocks are merely laid end to end without transverse bond.

5. The continuity of both horizontal and vertical air spaces. One of the most ingenious devices of this system of laying walls is the continuous horizontal air space which extends throughout the wall, making in effect two walls tied by the overlapping of webs in alternate courses; thus a very thorough insulation is secured, making a concrete wall construction impenetrable by moisture.

6. The securing of a very large percentage of air space. By the use of pressure as above outlined, combined with the use of true concrete and adequate moisture, this company has been able to increase the air space in a wall from an average of 30% under the one-piece systems to an average of 55% without any sacrifice of strength. Thus a great saving is made in the amount and cost of material and a corresponding decrease in the weight of walls, while the increased air space saves 25% of heating bills, renders a building cooler in the summer and affords walls practically dead as to sound.

7. The ability, on account of the through bond, to construct a wall of any length without providing expansion joints. Long walls of "one-piece" blocks have given trouble where such joints were not provided.

8. The greater ability to use the inside surface of an outside wall built by this process for a surface on which to plaster without furring and lathing. Those blocks to be used for inside face of the wall are left rough, without the application of a smooth finish, so that an excellent bond with the plaster is assured, and the wall being in two pieces can be kept in alignment very easily so as to insure a uniform thickness of plastering. Plate X. shows how continuous horizontal and vertical spaces throughout the wall are obtained.

The process of casting wet concrete in sand is very adaptable in buildings where the architecture requires arch stones, plain or fluted columns, ornamental caps and sills to windows or doors, ornamental water tubes and cornices, etc.

Patents Nos. 583,515, 699,587, 699,588, and 624,563, granted to C. W. Stevens are held by the Stevens Cast Stone Co., of Chicago, on this process. This company, in applying for a patent in Germany, was told that it was not believed possible to successfully cast concrete in sand, so men were sent to Germany to demonstrate the process. The patent was granted.

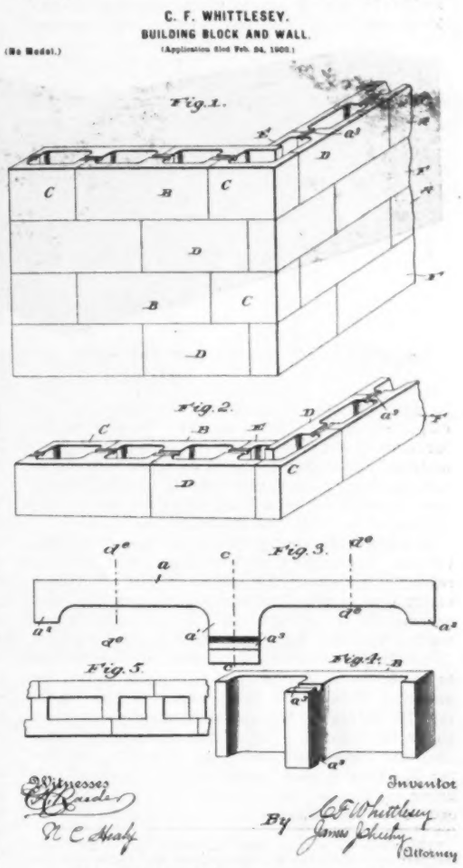


Plate IX. Whittlesey Patent of 1902.
Owned by American Hydraulic Stone Co.

These patents cover broadly the process of casting any shape, more particularly hollow shapes, of concrete in sand molds or molds partly of sand and partly of other materials. These molds are, in many cases, substantially the same as for casting molten metal, and the same quality of molding sand is used. It is questioned by many whether these patents will hold, and there have been much concrete block work done by this method where patent rights from the Stevens

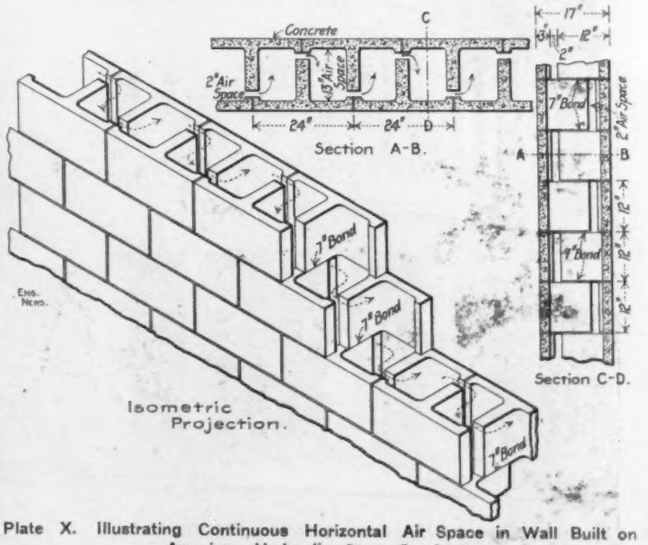


Plate X. Illustrating Continuous Horizontal Air Space in Wall Built on American Hydraulic Stone Co. System.

*Quoted from dictation by H. H. Rice, Secy. of American Hydraulic Stone Co., Denver, Colo.

Cast Stone Co. were not secured. It is certain that the process of casting any molten metal in sand molds would not be, at this late date, a patentable process. The Aberthaw Construction Co., of Boston, Massachusetts, cast all of the concrete steps for the Harvard Stadium in sand molds, by use of patent rights granted by J. C. McClennahan (Patent No. 711,436). This process,

PLATE XI. MULTIPLE AIR SPACE WALL OF THE MANDT CEMENT BLOCK CO.

in practice, is substantially the same as that employed by the Stevens Cast Stone Co., the McClennahan patent using in the sand or other mold a "hardening chemical solution." In practice, the writer has been informed, a small proportion of sulphuric acid is added to the water used in compacting the sand molds.

In Cuba this process seems to be open to competition to anyone who desires to use it, without regard to patents.* To the writer's mind, a local manufacturer should use some process that will accomplish the results of "casting in sand" to some extent (however he establishes his right to do so) in order to be able to take any work open to brick, stone, or concrete. A man could, for instance, acquire the local county or city rights for the American Hydraulic Stone Co.'s process, which he could use for all the main body walls, etc., and then could use "cast in sand" concrete for his lintels, sills, water tables, cornices, columns, arches, or any curved bow windows required, using reinforcement of steel rods or wire cloth, if desired, and be much better able to compete with stone or brick work.

The literature of the Mandt Cement Block Co., Stoughton, Wis., illustrates a novel multiple air space wall. This is a two-piece wall, as may be seen by the illustration, Plate XI. This is described quite thoroughly in "Municipal Engineering," July, 1905. Application for patent on this block and wall was filed May 10, 1905, and has not yet been granted. The bond is the same as that of the American Hydraulic Stone Co.'s two-piece system. (See Plate X.)

Attention is called to Patent No. 776,409 to A. C. Mather and M. F. Bowen. Plate XII. shows the plan of this block, which when laid up becomes a well-bonded wall with a hollow back, to the channel projections, on each block of which wire lath is attached for plastering. This form of block is one of the forms used by the American Hydraulic Stone Co. in its patented "two-piece" wall and could easily be made of impervious broken stone concrete on the machines of that company. The writer has seen no advertisements of any company using this block, but it should become a much-used form of wall.

The literature of the Queen City Brick Machine Co., Traverse City, Michigan, illustrates a process of making ordinary-sized bricks of concrete composed of sand and cement, by pressure, by use of their patented machinery (Patent 761,886). These bricks are all of the same size and may be made with ornamental faces, etc. Such concrete bricks should find a ready market, if the claims of the machine manufacturing company are not exaggerated.

In closing the patent rights question, the writer would refer to the list of patent numbers, etc., below, and would suggest that the prospective manufacturer of concrete blocks should read copies of these patents. These may be purchased from the U. S. Patent Office for five cents per copy.

The reader could examine the "Official Gazette of the United States Patent Office" for this purpose. This publication is issued weekly ($ per year) and gives a resumé of all patents issued. A complete index is issued annually. Every volume of this publication is on the shelves

No. 776,409. PATENTED NOV. 29, 1904.

NO MODEL. A. C. MATHER & M. F. BOWEN.
BUILDING BLOCK.
APPLICATION FILED JUNE 23, 1903.

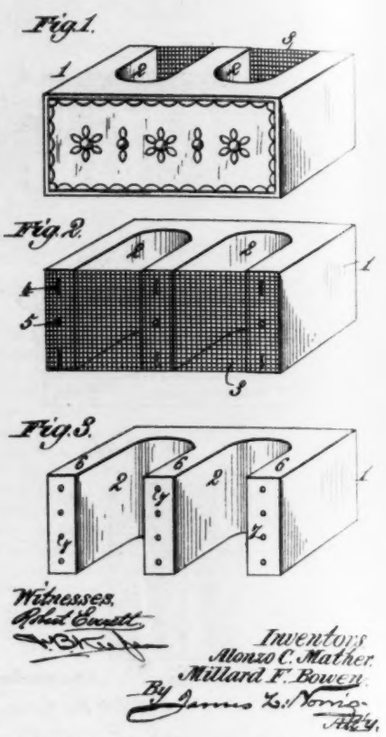


Plate XII. Mather & Bowen Patent. (Owned by American Hydraulic Stone Co.).

*The writer has since been informed that Purdy and Henderson control the Stevens patents for Cuba, and regard other manufacturers as infringers.

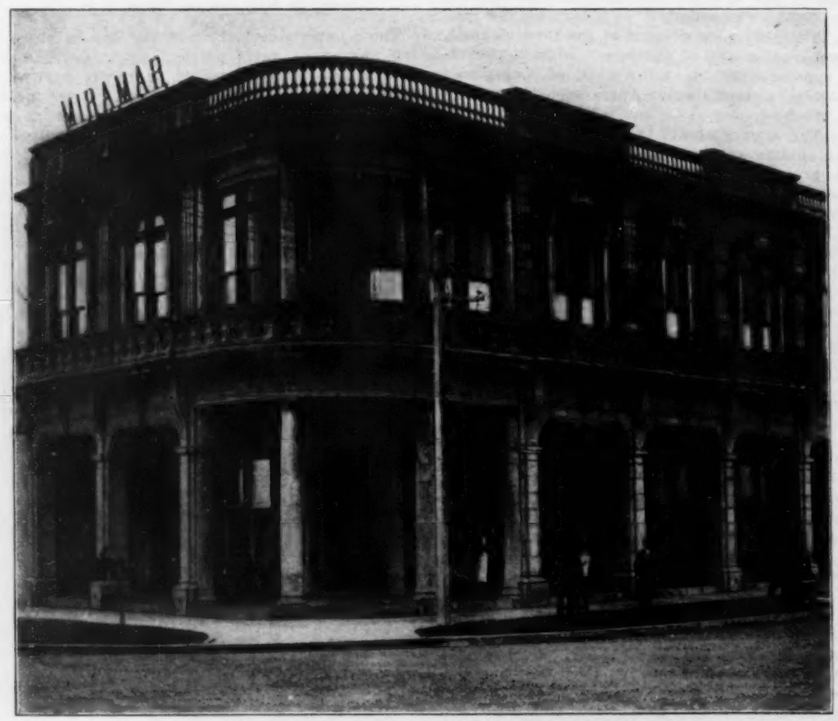


PLATE XIV. MIRAMAR HOTEL, HAVANA, CUBA.
Built of Concrete Blocks by Purdy & Henderson.

of the Astor Library, New York City, or in any large public library. This library also has on its shelves bound volumes of the complete drawings and specifications of all patents issued.

In 1904 alone about sixty patents bearing on the subject of "building blocks" were granted. Even a casual observer can see that many patents conflict.

Below is a list giving some of the more important patents:

IMPORTANT PATENTS BEARING ON THE SUBJECT OF CONCRETE BLOCKS.

Joseph Gibbs	13,071	(British Government)	1850
T. J. Lowry	80,358		1868
Theodore Hyatt	142,475		1873
T. B. Rhodes	149,678		1874
H. S. Palmer Co., Washington, D. C.	375,377; 674,874; 727,428;	623,680 727,427 759,010	1887 1904
Miracle Pressed Stone Co., Minneapolis, Minn.	730,780		1903
Blakeslee Concrete Block Machine Co., Columbus, O.		760,774	1904
Peter Dieriamm		744,835	1904
A. C. Mather & M. F. Bowen		776,409	1904
J. C. McClennahan		698,727 711,436	1902
Stevens Cast Stone Co., Chicago, Ill	583,515; 699,587;	624,563 699,588	1897 1902
Am. Hydraulic Stone Co., Denver, Colo.	704,606; 742,094; 749,796; 767,413; 769,601; 769,656; 771,816; 773,630; 775,847;	733,928 743,391 767 398 767,414 769,655 769,816 772,032 773,647	1902 1905

In purchasing patent rights one should, of course, be able to trace the right to deal in them from the selling company back to the patentee. The laws and court decisions relative to the common use of a patent by the employers of the man who developed the patent, and by the inventor himself, should also be considered, as one might purchase exclusive local rights of the one party only to encounter competition from the other.

3. COST.

(1) Establishing an Industry.

The amount of capital necessary to purchase a machine or outfit sufficient to make the equivalent of from 5,000 to 20,000 brick per day is in no case more than from $200 to $600. To this must be added credit or capital sufficient to obtain sup-

Plate XV. Examples of Concrete Blocks Cast in Sand at Havana.

plies, rent of land, use of teams, etc., to suit local conditions.

If the form of block, or the whole process, is patented, an additional sum must be paid for patent rights for the local use of the process. The companies holding these rights are all ready to sell exclusive local rights at rates ranging from $5 to $50 per thousand population. Sometimes a part of this payment may be made as a royalty on wall as made until whole contract amount is paid.

It is usually best to establish the industry near the source of supply of broken stone or sand, or near railroad yard or wharf where such material may be unloaded. Inasmuch as any considerable business will require an extensive plant of tram cars and sprinkler system to care for the blocks, etc., after being made, it will usually be best to make the blocks at a central yard and transport by team to the building site after they are cured and ready for the wall. The machinery is usually so light and portable, however, that for a large building it often pays to set it up at the site, and if this is done, the blocks may be put into the wall sooner after manufacture than would be the case if necessary to team them.

The advertising pages of "Engineering News," "The Cement Age," "Cement and Engineering News," "Municipal Engineering," and many other scientific journals contain advertisements of those firms which have been mentioned, as well as of many others. "Municipal Engineering" (No. 1 Broadway, New York), July, 1905, ($0.25 per copy) contains advertisements of 58 companies in the United States which make machinery or molds for the manufacture of concrete building blocks, or associated products. All of these companies have literature concerning their processes for distribution, and the writer would suggest that much of this literature deserves perusal, and the advertisements themselves are well worth reading. In corresponding with any of these firms, he would suggest also that special emphasis be laid on inquiries concerning patent rights, and concerning the ingredients which it is possible to use in the concrete, including the proportion of water, in order to determine probability of patent infringement legal troubles, and probable quality of product to be obtained by the process.

(2) Cost of Product.

The cost of any concrete building block depends on two things: The cost of the labor to mix the ingredients and that required to put the mixture through the machine or process. Ordinary broken stone concrete, mixed in proper proportions, in large masses, costs in place from $4 to $8 per cu. yd., depending on local cost of ingredients, and on the shape and size of the masses put together.

To put such concrete through the American Hydraulic Stone Company's machinery costs little more than the ordinary process of putting it into wooden forms, with the cost of form work included in the latter. Thus, in a wall made by this process with 50% hollow space, the actual cost to the manufacturer for the blocks is just about 50% of what the cost would be to build a solid concrete wall of the same outside dimensions, of same grade of concrete. The cost of labor of laying up the wall with these blocks is small, and so the total cost of the hollow wall is not much more than half of the cost of the solid wall. The ordinary manufacturer of these blocks makes a handsome profit on them at $0.15 or $0.18 per sq. ft. of wall, as the total cost may be as low as 6 cts. or 8 cts. for correctly made concrete. The actual cost of a 13-in. wall has been, in some cases, as low as 10 cts. or 11 cts. per sq. ft.

The cost of casting concrete blocks in sand is much greater, as the labor item is so much larger, the molds being set up anew for each casting, and labor of molding being comparatively high-priced. In Havana, Cuba, Purdy & Henderson, and J. B. Clow & Son have built a great deal of "cast in sand" hollow concrete block wall at from $5 to $6.50 per square meter ($0.46 to $0.60 per sq. ft.).

The process of casting the blocks by pouring wet concrete in metal molds is cheaper than by casting in sand. The Stevens Cast Stone Co., of Chicago, use this method for the straightaway work on many of their buildings, using the "cast in sand" method for only the ornamental or peculiar-shaped blocks required by the architecture, but using the same "wet" mixture of broken stone concrete throughout. This process is also used by the K. Dykema Co., Battle Creek, Mich.; The Electrical Concrete Post & Stone Co., Lake City, Ia., and several other companies. For the same grade of concrete this process makes more expensive walls than the "medium" concrete process of the American Hydraulic Stone Co., on account of the greater amount of outfit necessary.

Any concrete block machines on the market

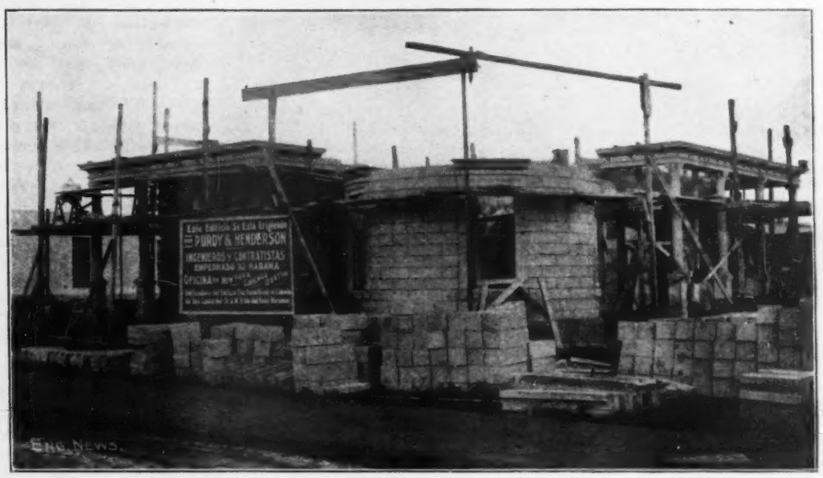


PLATE XVI. A HAVANA RESIDENCE UNDER CONSTRUCTION OF CONCRETE BLOCKS.

PLATE XVII. NEW ARMORY BUILDING, AMES, IA.
Built of Miracle Concrete Blocks.

which use the "dry" tamped process make blocks at prices which vary greatly according to the grade of the mixture employed ($0.15 to $0.50 per sq. ft. of wall). The tendency of this process is to use too little cement in order to keep the cost down, as it is possible to use only sand with the cement. Blocks made in correct proportions by this process would cost nearly as much as, or more than, concrete blocks of broken stone, sand and cement, made by the "cast in sand" process.

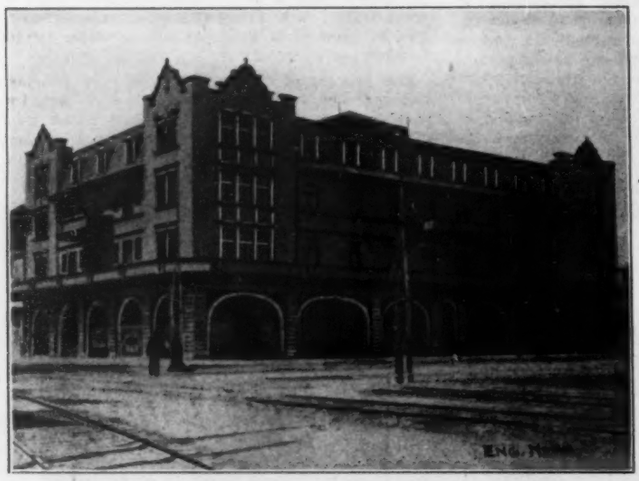


PLATE XVIII. HOTEL ANGELUS, EL PASO, TEX.
Built of American Hydraulic Stone Co. Concrete Blocks.

(3) Comparative Cost of Buildings of Concrete and other Materials.

The literature of nearly all of the manufacturers of concrete block machinery contains statements of comparative cost of walls made of their product, and of ordinary brick, stone, and wood. A careful perusal of this literature, or an investigation of workmanship, would show that many of these comparisons are overdrawn, or that, in order to make so cheap a wall as described, a poor mixture of concrete was used, and that the labor employed was not of the highest class.

In our large cities, labor unions control the building trades, but, as far as is known to the writer, neither union masons nor union bricklayers have as yet refused to lay a wall of concrete blocks, though these blocks were made by non-union labor. Trouble on this score is probably in store, however, if it ever assumes large proportions. The above mentioned unions have close working agreements with the stone cutters' union, the hod-carriers' union, etc. Unions of concrete workers demanding standard wages of the hod-carriers' union have already been formed, and if these unions become powerful, the item of labor will be increased, as the union bricklayers and masons who lay the wall will undoubtedly insist on having the concrete blocks made by union laborers. At the present time brick and stone masonry walls are built entirely by union labor from the brick yard and the quarry to the finished wall, and ultimately brick, stone and concrete work will all be on the same status in this respect, which is not the case at present.

It is certain, however, that concrete blocks are cheaper than cut stone, of the same durability, and much more adaptable, and for a hollow wall, concrete blocks cannot be successfully competed with by brick or stone. It is customary for concrete block machinery companies to compare the cost of the hollow wall of their product with a solid brick wall of same dimensions. It should also be remembered that the hollow concrete wall—if built by any moisture-proof process—does not need to have furring strips fastened to the inside for lathing and plastering. On a brick wall this furring and lathing are necessary, and so the comparison is still more in favor of the hollow concrete block wall. Moreover, the hollow concrete wall, of same size and strength as the solid brick wall, weighs only 50% to 75% as much as the latter, so money may be saved on the foundation, if on yielding soil.

In general, at the prevailing price of materials, building walls may be built of correctly made concrete blocks for from 40% to 75% of the cost of brick walls or from 25% to 50% of the cost of cut stone or fancy brick. In fact, by some processes a house may be constructed of this material for the cost of a good frame house, and the owner has the advantage of a non-burnable construction as well as of a much warmer building.

It should be noted, however, that the process, comparatively new in this country of making sand-lime brick may be destined to reduce the cost of brick walls to about 60% of their present cost. This process has been in use in Germany for many years. The ease with which bricks of a perfectly uniform size are turned out at a cost to the manufacturer of from $3 to $5 per M. renders them formidable competitors with any other building material. The reader is referred to "American Sand-Lime Brick Co.," 1307 Great Northern Building, Chicago, Ill., for data relative to this process. The Paragon Plaster Co., of Syracuse, N. Y., are successful manufacturers of these brick, as well as of the American Hydraulic Stone Company's "two piece" system of concrete blocks.

The process of "casting in sand" will sucessfully compete with cut stone or terra cotta for ornamental cornices, columns, balustrades, etc., for all places except perhaps points very near to the quarries or terra cotta works. For the same, or equally good appearance, and the same durability, the "cast in sand" process should not cost more than 60% of the others, while from the standpoint of fire-resisting qualities, there is no comparison, as the concrete would pass without damage a fire test under which cut stone or terra cotta would crumble.

A further comparison might be made by considering hollow walls built up of two separate walls of brick bonded together by metal strips, but to make a good and permanent wall by this method requires a very good metal. Galvanized iron, or copper strips should be used, and even these will sometimes rust through, so that the life of such a wall is not to be considered as great as one entirely of concrete materials.

Brick walls are often built in this manner, sometimes using an occasional "header" brick for the bond instead of metal strips. The cost of a hollow concrete wall will usually not be much less than a brick wall of same outside dimensions built in this manner, but it will be stronger on account of the more thorough bond.

Under present conditions, it is certain that hollow concrete wall construction is cheaper than equally good wall of other materials. This because of the cheapness of crushed rock and sand in nearly every locality, and the abundance of good cement mills all over the country. The brickwork, stone, or terra cotta, proximity to brick-yard quarries plays such an important part rendering the cost of construction at any siderable distance from these places very g on account of freight charges.

4. ASSOCIATED INDUSTRIES.

Fence posts, telegraph poles, flag stones, ing slabs, sewer pipes, piles, solid concrete b of ordinary brick size, etc., are made successf of concrete. In any locality there is also a gr deal of concrete work in cement sidewalks, crete floors, concrete roofing and basement ing, concrete steps, etc., that is constantly o to contractors.

A concrete block manufacturer could, in almost any locality, carry on some, or all, of these other lines of work to good advantage. He would also find in many places a good chance to engage in a mercantile business in cement, sand, crushed rock, etc. Such a business might enable him to purchase his own supplies in larger quantities, and hence on better terms.

5. ENGINEERING AND ARCHITECTURAL CONSIDERATIONS.

The concrete block business is not growing as it should. This is largely due to the objections raised by civil engineers and architects. The civil engineer argues that the ingredients in the concrete are not the proper ones, that too little water is used in mixing to make the block a success, and that the wall as built needs to be provided with expansion joints in spite of the bonding. The architect argues that, in spite of the claims to the contrary, the walls will be wet, and moisture will work through and spoil the decorations inside where plastering is done directly on the block; that the wall as made looks too artificial; that, if made of "rock faced" blocks, the patterns adopted are too much alike, and there are no sharp corners as in cut stone; that this makes the wall look as though it were faced with galvanized iron, stamped to imitate rock faced blocks, and then painted with a sand paint or cement grout; that in any case a concrete wall cannot be made to look like cut stone work; that the concrete presents such a poor appearance when wet, etc.

It is possible, however, to made concrete block buildings not subject to these objections. Purdy & Henderson, of Cuba, and the Stevens Cast Stone Co., in the United States, have erected buildings by the "cast in sand" process that do look like cut stone. The same is true of other processes. The poor appearance of wet concrete may be entirely obviated by choosing the sand and broken stone carefully. Clear white sand and crushed rock, with no iron or other coloring matter contained, are procurable, and if used give good results.

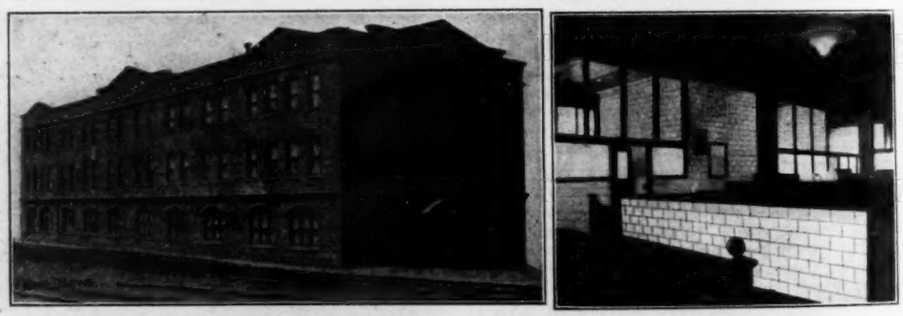


PLATE XIX. OFFICE BUILDING OF NATIONAL ELECTRIC CO., MILWAUKEE, WIS.
Built of American Hydraulic Stone Co. Blocks.

The reason for the necessity of providing expansion joints in a long wall of concrete blocks is that the wall is not bonded thoroughly enough. This defect is obviated in the best concrete block work.

The engineering and architectural authorities will be convinced by good results, and good re-

sults may be obtained. These professions are conservative. Therefore, great care and good workmanship must be used by the manufacturers of machinery, and of the blocks, to get their unqualified endorsement, without which it will never become an important industry.

6. SUCCESS SO FAR ACHIEVED IN THE INDUSTRY.

From an artistic standpoint, the best success in the industry has so far been achieved by means of the process of "casting in sand." In Havana, Cuba, this process has been extensively used. Plates XIII. and XIV. are photographs of "The Royal Bank of Canada" building, and the "Miramar" hotel building, both built by Purdy y& Henderson, of sand-molded blocks, except the flat portions of the wall near the second story windows in the Miramar, which are "dry" tamped blocks of the "Palmer" type. For reasons noted above, these buildings were quite expensive. Plate XV. shows a group of "cast in sand" blocks from Havana, and Plate XVI. shows a residence under construction.

In Cuba the ordinary "dry" hand-tamped block construction of the "Palmer" type has been largely discarded after having a good trial, as the slanting rain of the rainy season put moisture through walls built of such blocks in a few hours, and the firms now putting up buildings of concrete blocks use either "cast in sand" blocks or "dry" tamped blocks made impervious by the new invention of Purdy & Henderson described and illustrated above.

Plate XVII shows the new armory building at Ames, Iowa, built of "Miracle" blocks. This is a very handsome building and a credit to the Miracle Pressed Stone Company, Minneapolis, Minnesota, whose product makes a wall practically free (as a whole) from moisture on account of the "double air space" obtained in the wall. The Miracle Pressed Stone Company have granted their local patent rights to a great number of block manufacturing plants in the United States and Canada, and their testimonials from users from all latitudes show good protection from moisture, frost or temperature changes.

Plate XVIII shows the Hotel Angelus, El Paso, Texas, and Plate XIX shows the office building of the National Electric Company at Milwaukee, Wisconsin, built of the blocks of the American Hydraclte Stone Company. Besides the exterior view, an interior view showing the use of these blocks in inside work is given.

The Naugatuck Chemical Company, 25 Broad Street, New York Ctty, have recently erected a large building at Naugatuck, Conn., of these American Hydraulic Stone Company blocks, of which they are justly proud. This building is said to have cost 25% less than a common brick building would have cost, and a much better, and better looking building is the result.

Plate XX is a photograph of a portion of a residence of Normandin blocks, (Cement Machinery Company, Jackson, Michigan,) showing a good imitation of cut stone.

There has been much very unsatisfactory work in concrete building blocks. Most of this is traceable to the greed of the building block maker who, in order to reduce the cost and increase his profits has used poor concrete. The writer is well acquainted with a building built of "dry" tamped hollow blocks of the "Palmer" or "Normandin" type in which plastering on the inside of the walls was done directly on the blocks. The maker of the blocks stated that the hollow spaces insured dryness. The building is a very damp one on account of the porous nature of the concrete, both on account of being made a "dry" mixture, and on account of a too small proportion of cement in the concrete. Such a failure has given the concrete block business a set-back in that locality in the very beginning.

It must be remembered that there can be as much difference in imperviousness between a concrete block wall made of true broken stone concrete in "medium" or "wet" mixture, and a wall made of "dry" hand-tamped standard cement blocks, as there is between a vitrified paving brick and a common soft brick.

7. ADVANTAGES POSSESSED BY AN ENGINEER OR ARCHITECT OVER OTHERS IN HANDLING A SUCCESSFUL BUSINESS.

In first-class cut stone or terra cotta work, each block is made to size and shape from the plans made by the engineer or architect. In successful concrete block manufacture, each block must also be to size and shape from the plans. Otherwise, the resulting wall will not present the best appearance. The writer has seen concrete block walls in which joints in the successive courses of the wall were not broken, also walls in which the blocks have been cut by stone-cutters' tools after manufacture, simply because of lack of plans and proper supervision for the laborers employed in making the blocks. The reader is referred to an article in "Municipal Engineering," May, 1904, which illustrates this point.

An engineer or architect who, by education and training, is perfectly capable of making plans and laying out, or directing the laying out, of such work, and who is capable also of directing a business will have great advantage over a man who has no such training, and who therefore tries to do without such ability, or is forced to hire it. The partnership of a hard-headed business man and an engineer or architect would have its advantages. An engineer will usually have an advantage also in being better qualified to make or supervise tests of materials, etc.

The writer has had occasion above to refer to the work of Purdy & Henderson in Cuba. The success of this firm in concrete building block construction has undoubtedly been largely due to the engineering and architectural ability at its disposal.

The engineer and the architect are much more familiar with matter pertaining to the strength of materials, and are much more apt to insist on good and thorough workmanship in their work than competitors without their training.

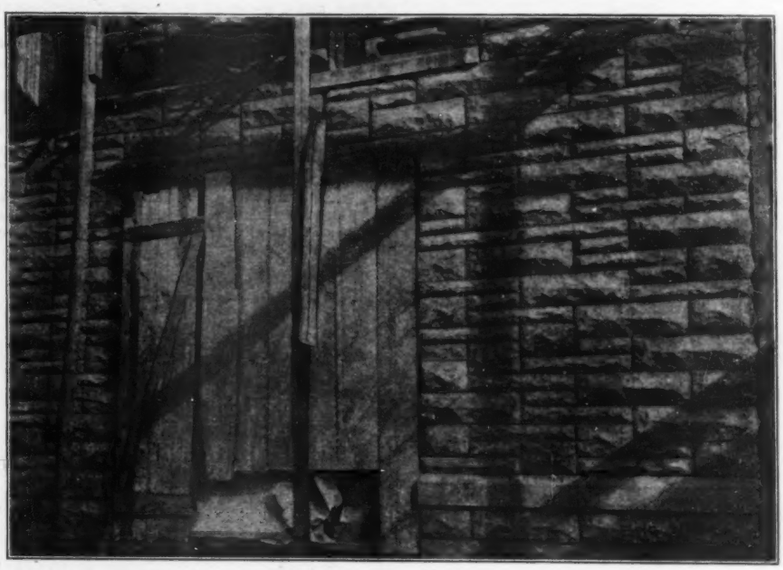


PLATE XX. PORTION OF WALL OF RESIDENCE BUILT OF "NORMANDIN" BLOCKS.

CONCLUSION.

It has been said that this is the "Age of Concrete." Cement manufacturers no sooner get their mills built than they are working overtime to fill orders. The growth of the cement industry is enormous, and shows no signs of ceasing. The demand for concrete instead of heavy masonry for bridge work; for reinforced concrete instead of structural steel and brick walls for skyscrapers, or industrial establishments; instead of brick or hollow tile and structural steel beams for floors; instead of brick or stone for dams, sewers, aqueducts, etc., is a steadily growing one. Now comes the demand for concrete block walls for buildings instead of brick, stone, or timber.

A concrete block business if founded on correct business principles as outlined in this article is almost sure to succeed. It is already an assured success in many places.

A business of erecting buildings of concrete building blocks with reinforced concrete floors and roofs is sure to be a popular one before very long. Many such buildings are now in use.

Not the least important consideration in concrete work is its great safety in case of fire. It has been shown that concrete is one of the very best materials of construction to resist fire. In the great Baltimore fire the buildings not destroyed were nearly all of concrete.

In this connection it is well to divide concrete into classes. Concrete walls made by any process giving a porous wall which will absorb moisture, will not withstand fire as well as concrete so compact that no moisture can be contained. In the one case the wall as a whole, on account of air space, double air space, introduction of waterproofing strata, etc., might be slow to allow moisture to pass entirely through the wall, but in case of fire, the confined moisture, previously absorbed, may become steam and crumble the wall. The writer would refer, in this connection, to an article by Noyes F. Palmer in Engineering News, July 13, 1905.

In general, however, the concrete building will prosper largely on account of the growing demand by owners of buildings that they shall have safety from fire to themselves, their families, or their business, and that they shall have lower rates of insurance or be able to do without insurance

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STREAM GAGING BY CHEMICAL MEANS is described in a paper by Charles Edmond Stromeyer, M. Inst. C. E. (Excerpts Proc. Inst. C. E., Vol. CLX., 1904-5, Part II.). The author had measured boiler feed water in the same way some years ago (Trans. Inst. Naval Architects, 1896, Vol. XXXVII., p. 226) and it appears that the same method has been used by at least one other experimenter (Le Génie Civil, 1904, Vol. XLIV., p. 411). Mr. Stromeyer states:

> In gaging by the chemical method, a fairly concentrated solution of some chemical for which very sensitive reagents are known is discharged, at a uniform and accurately known rate, into the stream under observation, and analyses are made of the water of the stream before and after the addition of the chemical. The ratio of the percentage of chemical in the concentrated solution to the percentage added to the water is obviously the same as the ratio of the volume of flow of the water per second to the volume of flow of the solution per second. Various salts can be used; in general, acids or alkalies would be employed with brackish or sea-water, and chlorides with hard water.

Tests with this method, as compared with rod-float, weir and Venturi meter measurements, on large and small streams, are described and illustrated in the paper and appear to show a fair degree of accuracy for the chemical method. It seems doubtful, however, whether the method is likely to appeal to engineers, owing to the many chances of error in its application and the necessity of resorting to chemical tests. Where continuous records are desired its limitations are obvious.

CONSTRUCTING A SUBMERGED WEIR BY OVERTURNING A TOWER OF CONCRETE BLOCKS.

The accompanying drawings show a novel and very interesting scheme which has been devised for constructing a submerged weir in the rapid current of the Niagara River. It was desired to increase the head of the water entering the fore-

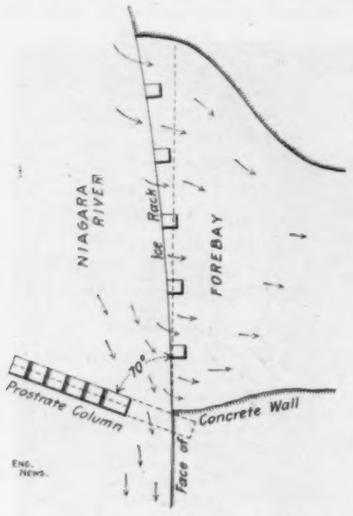


Fig. 1. Diagram Plan of Forebay and Proposed Submerged Weir, International Ry. Co., Niagara Falls, Ont.

bay of the power plant of the International Ry. Co. To do this it was decided to construct on the north or downstream side of the forebay intake, as shown in Fig. 1, a submerged wing weir with a space between it and the shore to serve as an ice runway. Owing to the rapid current and the unknown depth of water the ordinary methods of weir construction could not be employed, so the method illustrated was devised by the engineer.

As shown by Fig. 2, a timber tower 15 ft. high is erected on the river bank at the water's edge. This tower is so arranged that by means of rearward extending base timbers it can be tipped over into the river. On this timber tower is being built an obelisk 7.35 ft. square and 50 ft. high, composed of six concrete blocks, one, at the bottom, 10 ft. high, and five 8 ft. high each. In construction these blocks are separated by tarred paper, so that there is no adhesion between the concrete of successive sections of the obelisk. The blocks are, however, bound together by 2 in. diameter and 12 ins. long cast iron dowels, and by a continuous 1½-in. chain 50 ft. long. At the rear of the obelisk between each pair of blocks a loop is left in this chain by means of a few slack links, occupying a transverse horizontal recess or slot formed during construction. The forms for molding the blocks in place are shown by Fig. 3.

When completed as described, the obelisk is to be tipped over into the river by tilting up the rearward extending base timbers by means of jacks. The dowels and their own weight are expected to hold the blocks together as a unit during the overturning process. When the overturned structure strikes the bottom the dowels are expected to break and allow the blocks to adjust themselves to the contour of the bottom, while the chain maintains the continuity of the blocks. Owing to uncertainty as to the depth of water at the site of the weir it is not known yet whether or not one set of blocks will bring about the required result. Should one set not be sufficient two more obelisks will be overturned, one so as to lie alongside the first and the other so as to lie on top of the first two.

The method of construction above described has been devised by Mr. Isham Randolph, M. Am. Soc. C. E., of Chicago, Ill., Consulting Engineer to the International Ry. Co., to whom we are indebted for the information from which this description has been prepared. The first obelisk is now in process of construction.

THE COST OF STOPPING TRAINS, COMPARED WITH THE COST OF MAINTENANCE, OPERATION AND INSPECTION OF INTERLOCKING PLANTS.*

By J. A. Peabody.†

There exists in the minds of most railroad officials the idea that, if the factor of safety is left out, an interlocking plant is a luxury at any place where traffic is not so great that one is required to facilitate the movements so that all may be handled without increasing the track facilities, or where the time to be made by fast trains makes necessary the saving of every minute possible.

It has been my belief, for a long time, that this idea was erroneous and when a Division Master Mechanic made the statement that the temporary removal of a certain interlocking plant had cost his company $1,200 per month on account of the additional coal consumed alone, and made necessary on account of the additional stop for all trains, the fact was strongly impressed upon me.

Inquiries made of various officials as to the cost of stopping an average train (all kinds and weights included) on straight level track and accelerating speed up to that at which the train was running over the cost of running the same train without stop, brought forth a wide diverg-

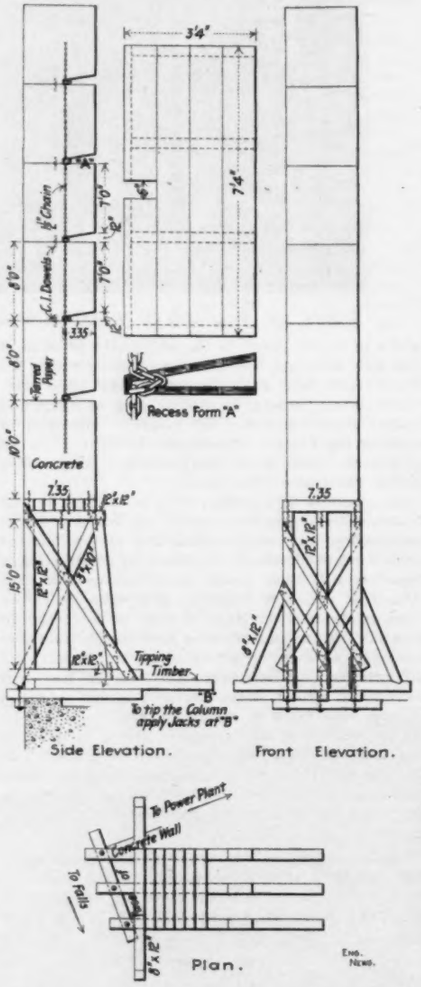


Fig. 2. Plan and Elevations of Concrete Block Tower to be Overturned to Form Submerged Weir.

ance of opinion and figures ranging all the way from five cents to five dollars. There was finally obtained a copy of a letter written by an official of one of the Western roads, as follows:

Dear Sir: There were no observations made during the test of Train No. 15, in 1900, as to the cost of stopping and starting trains. I have made a few estimates which may prove of interest. For trains such as Nos. 55 and 56, regularly eight cars between ..... and ....., and seven between ..... and ....., and total weight including engine and tender half loaded about 530 tons, the various items of stopping and starting, from and to a speed of 50 miles per hour are estimated as follow

Coal to stop train (air pump) 30 lbs.
Coal to accelerate train....275 lbs.

Total coal .....305 lbs. at $2.15 per ton.$0.32
Brake shoe wear, }
Tire wear, } .....
Brake rigging wear, }
Draft rigging wear, } .....
Miscellaneous, }
Total .....

The cost of brake shoes per stop is estimated from experiments now being conducted by the laboratory and in the course of a few months a more exact figure will be obtainable. The cost of tire wear, brake rigging wear, etc., per stop are estimated.

With reference to the time lost on account of train stops at various points, I have taken some figures from tests recently made on Trains Nos. 55 and 56. The point at which steam was shut off and the speed were noted and also the point at which the speed at shut-off was attained after starting up. The time in which the train would have covered this distance if no stop had been made, subtracted from the time it actually took, gives the time lost on account of stop, exclusive of time standing at the station.

Time Lost in Making Stops at Various Stations, Exclusive of Time Standing at Station.

Station.	Direction.	Speed at time steam shut off.	Seconds lost on account of stop.
.....	West	52 M.P.H.	169
.....	East	54 "	197
.....	West	50 "	128
.....	East	48 "	255
.....	West	30 "	90
.....	East	60 "	180
.....	West	52 "	155
.....	East	45 "	121
.....	West	52 "	119
.....	East	42 "	95

From the above it is seen that the time lost in making a stop (exclusive of time standing) on a straight and level track is about 145 seconds.

The records of some tests of Train No. 56 made in 1901, before the ..... interlocking plant was installed, have been gone over and compared with the tests on No. 56 recently made. The tests show the ..... interlocking plant has saved 85 seconds on the time of No. 56.

The cost of stopping and starting a 2,000-ton, 80-car freight train from and to a speed of 35 miles per hour would not be far from $1.00, itemized as follows:

Coal to stop train (air pump) 50 lbs.
Coal to accelerate train....500 lbs.

Total coal .....550 lbs. at $2.15 per ton.$0.56
Brake shoe wear..... 0.15
Other items (as classified above)..... 0.29
Total $1.00

Both in the case of trains Nos. 55 and 56 and the above freight train, the figures of coal used by the air pumps are based on tests; that required to accelerate the train calculated; and the item of brake shoe wear estimated from tests now going on; and all other items are purely estimates.

Yours truly, ...

Also from another road the following:

Dear Sir: Referring to our conversation and correspondence in regard to the cost of stopping a train, I have looked into this and herewith give you an itemized account of what I have figured on to form the totals for the stopping of passenger and freight trains.

SIX CAR PASSENGER TRAIN.

Coal for starting train and for air pump..... $0.28
Cost of wear and tear on brake rigging and shoes... 0.07
Total $0.35

1,500-TON FREIGHT TRAIN.

Cost for starting train and air pump use..... $0.40
Cost of brake rigging and shoe wear..... 0.16
Total $0.56

These amounts, however, do not take into consideration tire wear, possible wheel sliding, wear and tear of drawbars and other wear and tear on brakes, or liability of injury to freight in cars and possibly the breaking in two when stopping or starting. These figures, you understand, are low and the amounts would possibly be increased five to six cents in the case of a passenger train and 12 to 15 cents in the case of a freight train, if it would be possible to take into account all of the things I have mentioned above.

Hoping this will give you the information you desire, I am,

Yours truly .....

In the above record the speed of the passenger train was 45 miles per hour and that of the freight train 15 miles an hour.

A short time ago an experiment was made on still another road with the following results:

A 24-car freight train of 900 tons stopped from a speed of 45 miles per hour, and accelerated to a speed of 45 miles per hour after having run over the same distance at the same place. There was a loss of four minutes of

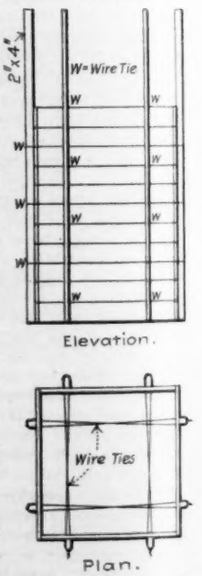


Fig. 3. Forms for Constructing Concrete Block Tower.

*Paper read at the annual convention of the Railway Signal Association, Niagara Falls, N. Y., Oct. 10, 11 and 12, 1905.

†Signal Engineer, Chicago & Northwestern Ry., Chicago, Ill.

time and the additional use of 440 lbs. of coal; the total distance covered in making this test was five miles, and care was taken to have the locomotive fire as near as possible the same at the beginning and end of each trip.

As all these figures were made on a separate basis, they cannot be directly compared. In the second letter there has been made no allowance for loss of time, as well as the other items mentioned, which in some cases would be considerable.

I have therefore considered that the figures were so conservative that they could not be disputed, and will use the average obtained from them (45 cts. in round numbers) in the following illustrations, Tables I to IX, as the cost of stopping any train; in all of these illustrations it is considered, unless otherwise noted, that additional men have to be employed to operate the interlocking plant.

The figures used for the cost of installing plants are high, and allowance made for electric locking, annunciators, etc., as usually installed in modern plants. The charges for maintenance and operation are sufficient for first-class work. The average interlocking plant with

TABLE I.—An Entrance to a Yard from a Double Track.

Cost of interlocking plant complete	$8000.00
Interest on cost at 4 per cent.	$ 320.00
Depreciation per year, 7 per cent.	560.00
Cost of maintenance per year	480.00
Cost of operation per year	1440.00
Total cost per year	$2800.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
17	$ 2800 00	$2800 00		$8000 00		
20	3285 00	2800 00	$ 485 00	8000 00	16.5 yr.	$ 12125 00
25	4105 00	2800 00	1305 00	8000 00	6.13 "	32625 00
30	4930 00	2800 00	2130 00	8000 00	3.8 "	53250 00
40	6570 00	2800 00	3770 00	8000 00	2.12 "	94250 00
50	8210 00	2800 00	5410 00	8000 00	1.48 "	135250 00
60	9855 00	2800 00	7055 00	8000 00	1.13 "	176375 00
70	11495 00	2800 00	8695 00	8000 00	11 mos.	217378 00
80	13140 00	2800 00	10340 00	8000 00	9.3 "	258500 00
90	14780 00	2800 00	11980 00	8000 00	8 "	299500 00
100	16425 00	2800 00	13625 00	8000 00	7 "	340625 00

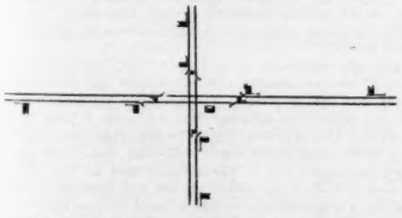
TABLE II.—A Single Track Crossing a Single Track.

Cost of interlocking plant complete	$7000.00
Interest on cost at 4 per cent.	$ 280.00
Depreciation per year, 7 per cent.	490.00
Cost of maintenance	420.00
Cost of operation per year	1440.00
Total cost per year	$2630.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
16	$2630 00	$2630 00		$7000 00		
20	3285 00	2630 00	$ 655 00	7000 00	10.7 yrs.	$16375 00
25	4105 00	2630 00	1475 00	7000 00	4.75 "	36875 00
30	4930 00	2630 00	2300 00	7000 00	3 "	57500 00
40	6570 00	2630 00	3940 00	7000 00	1.8 "	98500 00
50	8210 00	2630 00	5580 00	7000 00	1.25 "	139500 00
60	9855 00	2630 00	7225 00	7000 00	1 "	180625 00
70	11495 00	2630 00	8865 00	7000 00	9.5 mos.	221625 00
80	13140 00	2630 00	10510 00	7000 00	8 "	262760 00
90	14780 00	2630 00	12150 00	7000 00	7 "	313750 00
100	16425 00	2630 00	13795 00	7000 00	6 "	344875 00

TABLE III.—Double Track Crossing a Double Track.



Cost of interlocking plant complete	$9000.00
Interest on cost at 4 per cent.	$ 360.00
Depreciation per year, 7 per cent.	630.00
Cost of maintenance per year	480.00
Cost of operation per year	1440.00
Total cost per year	$2910.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
18	$2900 00	$2900 00		$9000 00		
20	3285 00	2900 00	$ 385 00	9000 00	23.4 yrs.	$ 9625 00
25	4105 00	2900 00	1205 00	9000 00	7.5 "	30125 00
30	4930 00	2900 00	2030 00	9000 00	4.43 "	50750 00
40	6570 00	2900 00	3670 00	9000 00	2.4 "	91750 00
50	8210 00	2900 00	5310 00	9000 00	1.7 "	132750 00
60	9855 00	2900 00	6955 00	9000 00	1.3 "	173875 00
70	11495 00	2900 00	8595 00	9000 00	1 "	214875 00
80	13140 00	2900 00	10240 00	9000 00	10 mos.	256000 00
90	14780 00	2900 00	11880 00	9000 00	9 "	297000 00
100	16425 00	2900 00	13525 00	9000 00	8 "	338125 00

TABLE IV.—Single Track Draw Bridge, Considering that Men Are Already Employed Who Can Also Operate the Plant.

Cost of interlocking plant complete	6000.00
Interest on cost at 4 per cent.	$ 240.00
Depreciation per year, 7 per cent.	420.00
Cost of maintenance per year	420.00
Cost of operation per year (supplies only)	120.00
Total cost per year	$1200.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
7	$ 1200 00	$1200 00		$6000 00		
10	1640 00	1200 00	$ 440 00	6000 00	14 yrs.	$11000 00
15	2465 00	1200 00	1265 00	6000 00	5 "	31625 00
20	3285 00	1200 00	2085 00	6000 00	3 "	52125 00
25	4105 00	1200 00	2905 00	6000 00	2 "	72625 00
30	4930 00	1200 00	3730 00	6000 00	1.6 "	93250 00
40	6570 00	1200 00	5370 00	6000 00	1.12 "	134250 00
50	8210 00	1200 00	7010 00	6000 00	10.3 mos.	175250 00
60	9855 00	1200 00	8655 00	6000 00	8.3 "	216375 00
70	11495 00	1200 00	10295 00	6000 00	7 "	257375 00
80	13140 00	1200 00	11940 00	6000 00	6 "	298500 00
90	14780 00	1200 00	13580 00	6000 00	5.3 "	339500 00
100	16425 00	1200 00	15225 00	6000 00	4.7 "	380625 00

TABLE V.—Single Track Draw Bridge, Considering that Extra Men Will be Required to Operate Plant.

Cost of interlocking plant complete	$6000.00
Interest on cost at 4 per cent.	$ 240.00
Depreciation per year, 7 per cent.	420.00
Cost of maintenance per year	420.00
Cost of operation per year	1440.00
Total cost per year	$2520.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
16	$ 2630 00	$2520 00		$6000 00		
20	3285 00	2520 00	$ 765 00	6000 00	8 yrs.	$19125 00
25	4105 00	2520 00	1585 00	6000 00	3.8 "	39625 00
30	4930 00	2520 00	2410 00	6000 00	2.5 "	60275 00
40	6570 00	2520 00	4050 00	6000 00	1.5 "	101250 00
50	8210 00	2520 00	5690 00	6000 00	1 "	142250 00
60	9855 00	2520 00	7335 00	6000 00	10 mos.	183375 00
70	11495 00	2520 00	8975 00	6000 00	8 "	224375 00
80	13140 00	2520 00	10620 00	6000 00	7 "	265500 00
90	14780 00	2520 00	12260 00	6000 00	6 "	306500 00
100	16425 00	2520 00	13905 00	6000 00	5 "	347625 00

TABLE VI.—Double Track Draw Bridge, Considering that Men Are Already Employed who Can Also Operate the Plant.

Cost of interlocking plant complete	$7,000.00
Interest on cost at 4 per cent.	$ 280.00
Depreciation per year, 7 per cent.	490.00
Cost of maintenance per year	420.00
Cost of operation per year (supplies only)	120.00
Total cost per year	1310.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
8	$ 1310 00	$1310 00		$7000 00		
10	1640 00	1310 00	$ 330 00	7000 00	21 yrs.	$ 8250 00
15	2465 00	1310 00	1155 00	7000 00	6 "	28875 00
20	3285 00	1310 00	1975 00	7000 00	3.5 "	49375 00
25	4105 00	1310 00	2795 00	7000 00	2.5 "	69875 00
30	4930 00	1310 00	3620 00	7000 00	1.9 "	90500 00
40	6570 00	1310 00	5260 00	7000 00	1.3 "	131500 00
50	8210 00	1310 00	6900 00	7000 00	1 yr.	172500 00
60	9855 00	1310 00	8545 00	7000 00	10 mos.	213625 00
70	11495 00	1310 00	10185 00	7000 00	8 "	254625 00
80	13140 00	1310 00	11830 00	7000 00	7 "	295750 00
90	14780 00	1310 00	13470 00	7000 00	6 "	336750 00
100	16425 00	1310 00	15115 00	7000 00	5.5 "	377875 00

TABLE VII.—Double Track Draw Bridge, Considering that Extra Men Will be Required to Operate the Plant.

Cost of interlocking plant complete	$7000.00
Interest on cost at 4 per cent.	$ 280.00
Depreciation per year, 7 per cent.	490.00
Cost of maintenance per year	420.00
Cost of operation per year	1440.00
Total cost per year	$2630.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
16	$ 2630 00	$2630 00		$7000 00		
20	3285 00	2630 00	$ 655 00	7000 00	10.7 yrs.	$16375 00
25	4105 00	2630 00	1475 00	7000 00	4.75 "	36875 00
30	4930 00	2630 00	2300 00	7000 00	3 "	57500 00
40	6570 00	2630 00	3940 00	7000 00	1.8 "	98500 00
50	8210 00	2630 00	5580 00	7000 00	1.25 "	139500 00
60	9855 00	2630 00	7225 00	7000 00	1 "	180625 00
70	11495 00	2630 00	8865 00	7000 00	9.5 mos.	221625 00
80	13140 00	2630 00	10510 00	7000 00	8 "	262760 00
90	14780 00	2630 00	12150 00	7000 00	7 "	313750 00
100	16425 00	2630 00	13795 00	7000 00	6 "	344875 00

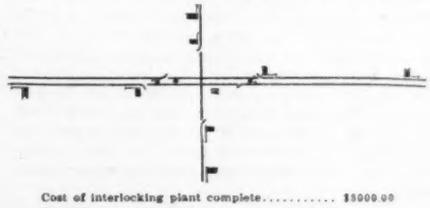
TABLE VIII.—A Single Track Crossing a Double Track, including Station Switches.

Cost of interlocking plant complete	$10,500.00
Interest on cost at 4 per cent.	$ 420.00
Depreciation per year, 7 per cent.	735.00
Cost of maintenance per year	480.00
Cost of operation	1440.00
Totol cost per year	$3075.00

SAVING TO BE EFFECTED.

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
19	$ 3075 00	$3075 00		$10500 00		
25	4105 00	3075 00	$ 1030 00	10500 00	11.9 yrs.	$ 25750 00
30	4930 00	3075 00	1855 00	10500 00	5.6 "	46375 00
40	6570 00	3075 00	3495 00	10500 00	3 "	87375 00
50	8210 00	3075 00	5135 00	10500 00	2 "	128375 00
60	9855 00	3075 00	6780 00	10500 00	1.5 "	169500 00
70	11495 00	3075 00	8420 00	10500 00	1.25 "	210500 00
80	13140 00	3075 00	10065 00	10500 00	1 "	251625 00
90	14780 00	3075 00	11705 00	10500 00	11 mos.	292625 00
100	16425 00	3075 00	13350 00	10500 00	9 "	333750 00

TABLE IX.—A Single Track Crossing a Double Track.



Cost of interlocking plant complete	$9000.00
Interest on cost at 4 per cent.	$ 320.00
Depreciation per year, 7 per cent.	560.00
Cost of maintenance per year	480.00
Cost of operation	1440.00
Total cost per year	$2800.00

SAVING TO BE EFFECTED

Trains per day	Cost per year acct. stopping trains	Total cost per year interest, deterioration, maintenance and operation	Net saving per year	Cost of Interlocking Plant complete	Time required to pay for installation from saving	Saving—capitalized at four per cent.
17	$ 2800 00	$2800 00		$8000 00		
20	3285 00	2800 00	$ 485 00	8000 00	16.5 yrs.	$12125 00
25	4105 00	2800 00	1305 00	8000 00	6.13 "	32625 00
30	4930 00	2800 00	2130 00	8000 00	3.8 "	53250 00
40	6570 00	2800 00	3770 00	8000 00	2.12 "	94250 00
50	8210 00	2800 00	5410 00	8000 00	1.48 "	135250 00
60	9855 00	2800 00	7055 00	8000 00	1.13 "	176375 00
70	11495 00	2800 00	8695 00	8000 00	11 mos.	217375 00
80	13140 00	2800 00	10340 00	8000 00	9.3 "	258500 00
90	14780 00	2800 00	11980 00	8000 00	8 "	299500 00
100	16425 00	2800 00	13625 00	8000 00	7 "	340625 00

proper maintenance will last 20 years, but to be on the safe side, I have only allowed for a life of 15 years. The results are given as though one road only was to pay the total expense; whereas, with crossings the expense is generally divided between the two roads participating.

Each actual case should, of course, be taken up as a separate proposition, and the estimates made with due regards to the local conditions and traffic; far better results can usually be shown than given in these examples, as freight trains are generally more numerous than passenger, and the average saving per train would be increased in proportion.

WATER POWER PLANTS ON THE APPLE RIVER, WISCONSIN.

The plant of the Apple River Power Co. comprises two water-power electric generating stations about 2½ miles apart, with a high-tension transmission line delivering current to New Richmond, Wis., 8 miles, and Stillwater, Minn., 12½ miles, for lighting and power purposes. The two plants are run in multiple with each other. One of the plants is an old one rebuilt and equipped, while the other is entirely new, having only been completed within the present year. The power company is backed by the Western Gas & Investment Co., of Chicago, and all the construction and reconstruction work was designed by Mr. R. S. Feurtado, Chief Engineer of the latter company, while the work was also done under his immediate direction by day labor. We are indebted to Mr. Feurtado for plans, reports and other information used in the preparation of this article.

The Apple River Power Co., of New Richmond, Wis., was incorporated in May, 1897, to purchase and improve a water power plant at Somerset and to build a transmission line to New Richmond, a distance of eight miles. It afterwards obtained the rights to build another plant at Riverdale. The Somerset and Riverdale dams of the company are on the Apple River which discharges into the St. Croix River, 12 miles above Stillwater, Minn. It has a remarkably even flow, rarely rising above the banks, and having a minimum flow of 22,000 cu. ft. per minute. In June, 1905, there was a phenomenal maximum flow of 85,000 cu. ft. per minute, following heavy rains.

SOMERSET POWER STATION.

The Somerset dam is of timber crib construction, filled with rock and planked on the upstream side with 2-in. matched lumber, making water-tight joints. It was built about 20 years ago and the foundations were reinforced with concrete by the present company in 1897. The available head is about 16½ ft., which could be increased to 17½ ft. by dredging and widening the tail race. The dam has a spillway 48 ft. long, with a wooden footbridge, from which needles are placed in the spillway in times of low water. The length of the dam is 200 ft., the timber construction being 120 ft. long and the balance consisting of earth embankments at each end. This summer the dam was provided with a Coffin 60-in. circular iron gate, having a screw and hoisting gear by which one man can operate it under a full head of water. The reservoir formed by the dam has an average width of 100 ft., and extends 2½ miles up stream, but the upper limit is 7 ft. below the level of the tail race of the new Riverdale dam (described below), so that it cannot cause any interference with the other power plant.

The dam has two flumes, of timber construction, 10 × 36 ft., and 12 ft. deep. In one of these is a pair of 42-in. New American turbines of 400 HP., the shaft of which extends through the bulkhead and has a pulley belted to a National 250 KW., 2,300 volt, three-phase, 60-cycle generator running at 450 revolutions. In the other flume is a pair of 42-in. McCormick turbines of 500 HP., which drive a similar generator in the same way. Each generator has its exciter directly coupled to the field shaft, and each turbine has a Woodward governor. The power house is an old timber mill building, and is heated by hot water. Besides the generators it contains a triplex power pump driven by a 2 HP. electric motor; this supplies water for cooling the transformers and for fire protection. About 50 ft. from the power house is a transformer and lightning arrester house, 14 × 18 ft. inside, and 12 ft. high. This is of stone, with concrete floor and wooden roof, and contains three 200-KW. oil insulated, water cooled transformers, and Westinghouse low-equivalent lightning arresters. The new plant was put in operation in October, 1904. The current is generated at 2,300 volts, stepped up to 15,000 volts, and transmitted 10 miles to Stillwater, Minn.

RIVERDALE POWER STATION.

This is a new station, built in 1904-1905. Fig. 1 shows the dam and power house. The dam is 500 ft. long, of which the middle 160 ft. is of concrete, while at each end is an earth embankment with concrete core wall. The dam, Fig. 2, is 26 ft. high; the concrete of the central part is in proportion of 1:4:8, and that of the outer part 1:3:6, while the downstream side is finished with a 6-in. facing of 1:2. The undisturbed central core of sand under the base reduces the amount of concrete and increases the resistance to sliding, while end walls of concrete protect this core from any action of the water. The downstream side of the spillway is designed with a "high-water" curve; that is, a curve which the overflowing water will hug closely at its highest stage, instead of shooting clear of the dam and leaving a vacuum at the face. In the concrete apron there is a depression 6 ins. deep and 9 ft. wide, causing the water to shoot out over the downstream toe; the flat portion of the concrete apron prevents any back eddy which might occur if the depression extended to the end of the apron. The earth embankments flanking the concrete dam are 26 to 30 ft. high. 12 ft. 6 ins. wide on top, with slopes of 1 on 1½ for the upstream side and 1 on 2 for the downstream side. Below the base of the embankment is a trench 2 ft. wide and 5 ft. deep, filled with concrete; and upon this is built the concrete core wall, 18 ins. thick at the base and 6 ins. at the top. The embankment was built with wheeled scrapers and dump wagons, and was thoroughly consolidated by the horses and wheels.

Fig. 3 is a section through the dam at the power house, showing the position of the flume, penstock, draft tube and generator. Fig. 4 is a view of the downstream side during a period of high water; the photograph was taken June 5, 1905. At the right is the power house, showing a corner of the tail race; next to this is the sluiceway, with two of the three gates wide open. At the left is the spillway, over which the water is flowing with a depth of about 3 ft. Fig. 5 is a view of one of the 250-KW. generating units. At the left is the end of the wheel case, against which are the ball governor and the wheel gate operating mechanism, driven respectively by belts from the hub and flange of the coupling between the wheel shaft and generator shaft. The generator pulley is belted to the exciter unit. On the wall are the steam radiators.

The following description of this dam and power plant is condensed from the engineer's report:

The dam proper is entirely of concrete construction. Owing to the fact that bed rock could not be reached, all of the foundations were carried down to a depth of 15 ft. below the bed of the river, and a row of piles 5 ft. long, made of old rails, was driven the entire width of the concrete portion of the dam, the heads of these piles being left so that they would be embedded at least 12 ins. in the concrete forming the lower portion of the foundations. These piles were driven as close together as possible, so that the footing of the dam is practically 19 ft. below the bed of the river. The base of the dam, where the power house stands, is 55 ft. wide; that is, up and down stream. The base of the spillway is 37 ft. wide, up and down stream. The total weight of the dam is about 14,000 tons, including concrete, machinery and building.

This dam has a spillway 56 ft. wide and 20 ft. above the bed of the river. There is a waste-way 22 ft. wide, which is provided with three Coffin 48-in. circular iron gates, having hoisting apparatus of such power that one man can raise or lower these gates under 24 ft. head of water. The forebay is 40 ft. wide, and is provided with the necessary trash racks, to prevent debris from getting into the wheels.

The power house, Figs. 1 and 3, is built on the extreme east end of the concrete part of the dam, and becomes part of the dam proper. In this power house there are two steel penstocks, 11 ft. diameter. In each penstock is located a pair of McCormick turbines of 500 HP. capacity. The water is led from the forebay into these penstocks by two steel flumes embedded in the masonry of the forebay, each of which is 10 ft. diameter. At the entrance of each of these flumes is provided the necessary head gate, 11 ft. square, made of Oregon fir timbers 8 ins. thick, bolted together and made water tight. Each gate is provided with two gate stems, which are bolted the proper cast iron racks, which engage with a pinion, thereby forming the necessary connection between the gate and the hoisting apparatus. With this apparatus one man can raise or lower the gate.

Inside the power house, and outside of the penstocks is the rigging which operates the cylinder gates for the water wheels. All of this rigging, including bevel gears, shafting, counterbalance weights, etc., is exposed in the power house, thus giving free access for inspection, even at all times. The shafts of the water wheels extend into the power house, and to them are directly connected two 250 KW., 2,300 volt, three-phase, National Electric generators, running at 189 revolutions per minute. On each water wheel is connected a Woodward governor. There are three water-cooled oil-insulated transformers of 200 KW., which step-up the current from 2,300 volts to 15,000 volts.

The step-up transformers, lightning arrester, and circuit breaker equipment, are all located inside the power house, and are of the same type, capacity and make as equipment at Somerset; so that with the exception of the construction of the dam, the power house, and location of transformers, and so on, the Riverdale plant is a duplicate of the Somerset plant.

The building at Riverdale is of hollow brick, constructed with 12-in. walls and veneer brick on the outside. The power house is 50 ft. × 40 ft. and 24 ft. high (internal dimensions), and has iron roof trusses with matched lumber roof boards covered externally with corrugated iron. The floors are of concrete, and all wires are laid in conduits under the floor. The three step-up transformers are placed near the back of the building. Adjoining the power house on the east is a building 16 ft. × 28 ft., divided into two rooms, one of which is used for coal storage; and in the other is located a small steam boiler for heating purposes. The building is heated by steam generated in this boiler, and all the pipes and radiators are bolted to the wall, so that they do not interfere with the floor space.

DETAIL OF DAM CONSTRUCTION.

Mention has already been made of the depth to which foundations were carried, as well as the extra depth atttained by driving sheet piling of old rails. Sand, commonly known as "torpedo," is what was encountered from the surface of the bed of the river down to the depth of 15 ft., and over 3,000 cu. yds. of this material were removed. All the sand excavated was used in making concrete. Rocks were obtained from the bed of the river, and from farmers who had plowed them out of their fields and had had them stacked up for years. These were crushed to pass a 1½-in. ring by a Gates crusher which was put up on the works and operated by an electric motor. Concrete was mixed by a Smith concrete mixer, which was also operated by an electric motor. The concrete was conveyed in wheelbarrows, and dumped and tamped into the different portions of the dam, special care being taken that the work should progress uniformly, so that there were no breaks or seams in the work.

About 5,000 cu. yds. of concrete were used in this dam, of which 4,500 yds. were composed of 1 part of Owl Portland cement, 3 parts of clean washed river sand, and 6 parts of broken rock. The balance was a mixture of 1 part of cement, 4 parts sand, and 8 parts of broken rock, this being used above high water mark and where there would be no pressure against the work. The spillway and all down stream exposures were given a smooth finish.

Across the spillway is a foot bridge, from which "needles" or flash boards can be inserted and the head kept up during low water. The available working head is 24 ft., while the spillway was built for a head of only 20 ft. This was done from the fact that there were certain farm lands which would be flooded, and for which we had no deeds, and it was thought best to keep the head down, so that in case we could not purchase this flowage at a reasonable price, there would be no claim for damages against the company. These flowage rights have since been acquired, so that instead of the head of water being 20 ft., it is 24 ft. On top of the dam a substantial 2-in. iron pipe railing has been put up, so that the danger of workmen slipping off of any part of the dam during winter, owing to snow and ice that might be on the dam, has been entirely removed.

At a distance of 15 ft. below the down-stream toe of the dam, a line of piles of old rails 10 ft. long was driven to a depth of 10 ft. into the bed of the river, leaving the tops flush with the bed. The sand and gravel were then removed to a depth of 4 ft., and into this space large heavy boulders were deposited (as shown in Fig. 1). At 15 ft. and 30 ft. below this first line, two other rows of piles were driven in the same manner, giving an apron 45 ft. in length (up and down stream), so there is not the slightest chance of the water flowing over the spillway or through the flood gates washing out the bed of the river at the lower toe of the dam.

On April 24, 1905, the river was diverted back to its old course, and against the dam, and allowed to flow through the three 48-in. flood gates, after which the

building of what is known as the east embankment was started. The mill pond was filled for the first time May 17, and a small leak developed on the west embankment, which made it necessary to immediately draw down the mill pond and build a concrete wall (150 cu. yds.), so as to further strengthen the embankment where it joined the masonry.

On June 6 the river began to rise very rapidly, and filled the mill pond. It continued rising for 24 hours, till a point was reached that was before unknown to any of the inhabitants of St. Croix County who have been familiar with the Apple River. This high stage of water continued for ten days, and the new embankments stood the pressure without showing any signs of weakness. The mill pond remained full until July 18, when it was drawn down, and a careful examination of the embankments on the up stream side failed to show the slightest indication of settlement of any kind.

From the fact that the mill pond is 500 ft. wide, and exposed to the north wind, causing waves, the upper face of the earth embankment has been riprapped with dry stone, so that there will be no danger of the embankments being damaged by the wash of waves from the mill pond. The mill pond and flowage for the Riverdale dam comprises an area 1¾ miles up stream, and an average width of 300 ft.

HIGH-TENSION TRANSMISSION LINE.

The transmission line from the power stations to Stillwater (10 miles from Somerset and 12½ miles from the Riverdale station) is built on the right-of-way purchased by the company. It has poles of Michigan cedar 25 to 45 ft. long with anchors and guys where necesssary, and having 4 ft. cross arms; double poles and double arms are used at angles, etc. The Locke brown porcelain insulators (tested to 60,000 volts) are fastened to the cross arms and ridge irons by steel pins with porcelain bases, and form a triangle with 40-in. sides.

The line wire is of aluminum strand, of a conductive capacity equal to No. 4 copper wire. I am very much pleased to report the absolute success with the use of this aluminum wire, and may point out some of the advantages derived from its use. First of all, the weight of this wire is about 48% of the weight of No. 4 copper wire, and this difference in weight is of great benefit to the poles and cross arms. While the size of the aluminum wire is considerably in excess of the size of No. 4 copper wire, as far as area is concerned, I find that during the winter less sleet forms on the aluminum wire than on copper wire, so this is another advantage in using it.

This line has been in use since July 20, 1904, and we have never been called upon to repair a break in it. In one or two instances the line was evidently put up too taut, and it became necessary to cut it and insert a piece, so as to take the strain off of the insulators on the angles. Other than this there has been absolutely no trouble with the line.

The high tension pole line crosses the right-of-way of the Wisconsin Central Ry., half a mile east of Somerset station, and while the railway gave permission to go overhead, the power company could not get the deed across right-of-way till after it had purchased and installed a cable conducting electricity under the track, instead of overhead. This cable was procured and put into service in April, 1905, since which time the company secured the necessary deed for right-of-way across and under the Wisconsin Central Ry. tracks. As a precaution and a means of giving uninterrupted service in case the cable should be damaged by lightning, the company maintains a system of overhead wires, which, by agreement with the railway, will always be "dead," except at such times as the cable might be damaged and could not be used.

At either end of the cable, lightning arrester houses are located, in which are installed Garton lightning arresters, with capacity of 15,000 volts. During the severe

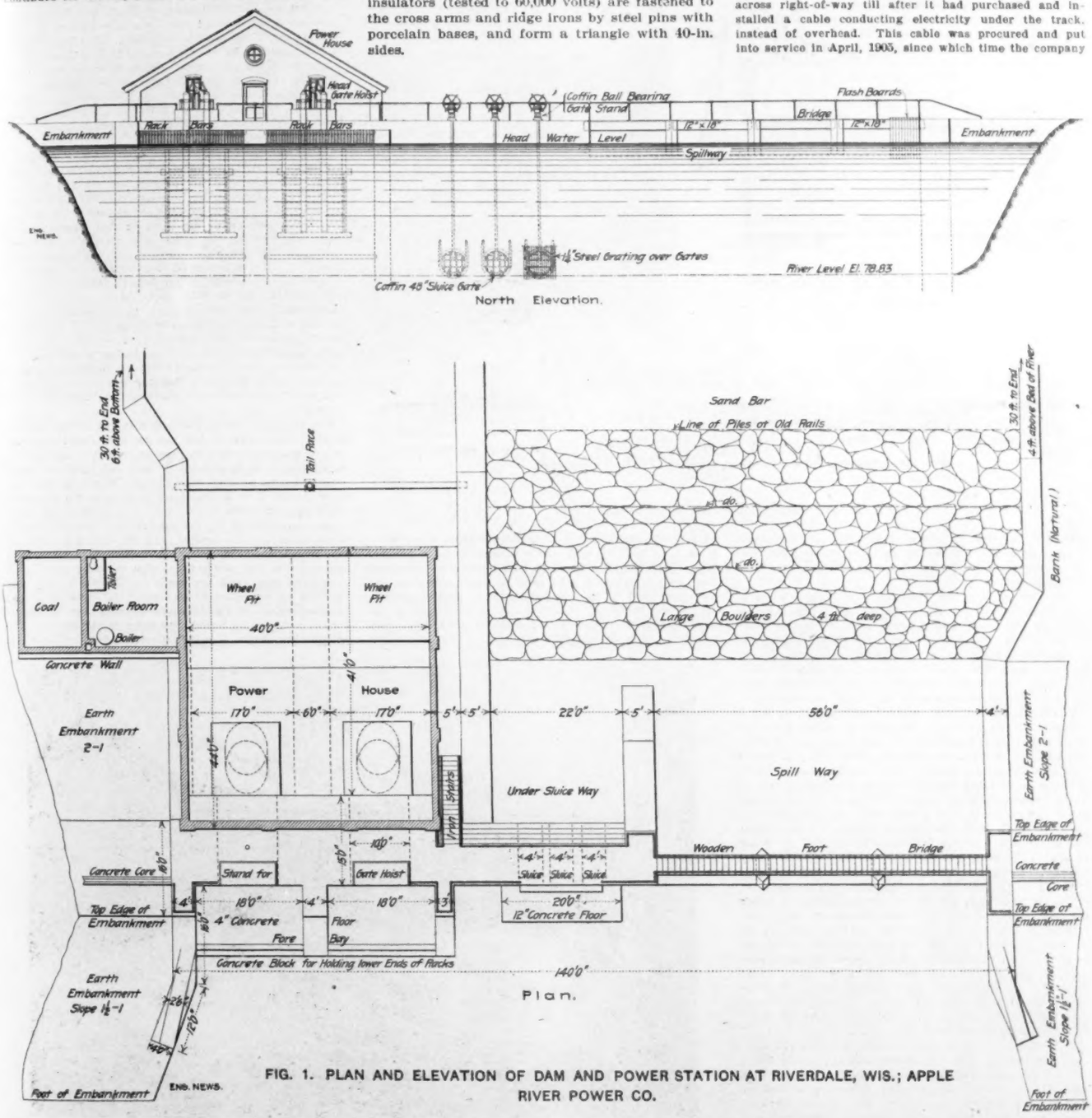


FIG. 1. PLAN AND ELEVATION OF DAM AND POWER STATION AT RIVERDALE, WIS.; APPLE RIVER POWER CO.

thunderstorms that prevailed during May, June and July of this year, the lightning arresters evidently did their work, from the fact that the cable was not damaged. For half a mile either side of the cable, where the line passes through a heavy wooded country, and where the trees show the effect of severe damage by lightning, two No. 8 galvanized wires are placed, one either side of the pole, equidistant between the three legs of the transmission line, and grounded at every pole. There is evidence to prove that these have worked successfully, from the fact that the poles, cross arms, and cross-arm braces show where lightning has struck the poles, followed the braces and jumped across to these wires and to the ground.

The high tension line crosses the telephone wires of the Northwestern Telephone Co. in three places before reaching Stillwater, and in each case the Apple River Power Co. has stood the expense of having the proper protection put up by the telephone company, in accordance with their specifications and the views of their engineers, so that all responsibility for damage to their wires or employees rests with the telephone company.

The high tension line crosses Lake St. Croix on a bridge 1,800 ft. in length, and the franchise from the city of Stillwater (granted to the Stillwater Gas & Electric Light Co.) gives the right to erect and maintain a pole line across this bridge. St. Croix Lake being navigable, it is provided with a pontoon drawbridge, and an armor-covered submarine cable 525 ft. in length is laid under the water at this drawbridge. An overhead line on poles 80 ft. high (so that all obstruction to navigation is avoided) was also put up. The overhead wires are in use all the time, and the cable can be cut in in a few minutes, should storms injure the overhead wires.

For lightning protection for this cable, at the east end of the bridge is built a lightning arrester house, in which are installed three sets of Westinghouse low equivalent arresters, with kicking coils; one set for each leg of the transmission line. On the poles at each end of the cable are built boxes in which are housed a set of Garton lightning arresters for each leg of the cable, so as to give protection to both sides of the cable. Weatherproof wire is used from the bridge through the city of Stillwater, up to and into the sub-station, which is located about 2,000 ft. from the bridge.

This sub-station is located temporarily in the old electric light station of the Stillwater Gas & Electric Light Co., and the station equipment consists of a set of Westinghouse low-equivalent lightning arresters, located in the lightning arrester house in the yard of the company. Immediately on entering the building, the wires run into a set of Westinghouse stick type circuit breakers. From thence they enter into delta connection on the high-tension side of the three National step-down transformers, which are three in number, each having a capacity of 600-KW., 15,000 to 1,100 volts, 60 cycles. These transformers are oil insulated and water cooled, being identical in construction, etc., with those at Somerset and Riverdale. The low tension side of the transformers is also delta connected, and leads directly to the switchboard.

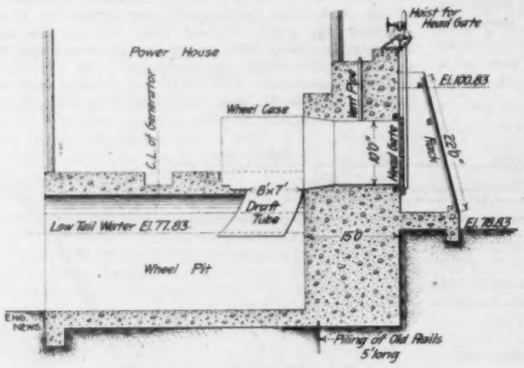


FIG. 3. CROSS-SECTION AT FLUME AND WHEEL PIT.

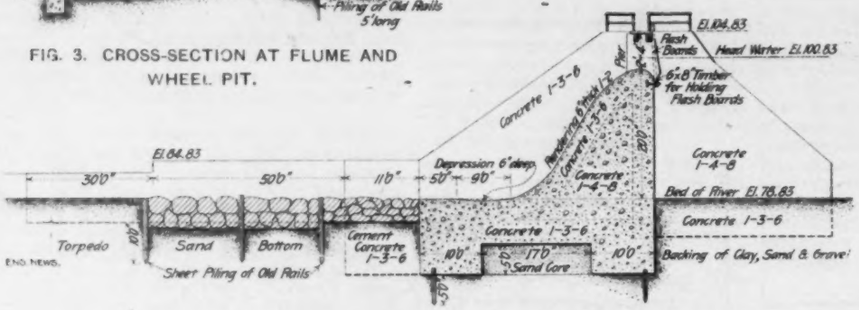


FIG. 2. CROSS-SECTION OF RIVERDALE DAM.

BUILDING FOUNDATIONS IN CHICAGO.

The construction of foundations is a very interesting question in Chicago, where tall and heavy buildings are being constructed in great numbers and where the soil is a clay of varying degrees of softness, underlaid by a stratum of hard pan, and with rock at depths of 50 to 110 ft. The development of foundation construction under these conditions was described in our issue of Dec. 22, 1904. At the meeting of the Western Society of Engineers on Sept. 20, a talk on this subject was given by Mr. J. M. Ewen, M. Am. Soc. C. E., who has had a large and varied experience in this class of work. From his address we take the following notes:

In the downtown district, rock is 100 to 110 ft. below the surface; over this are various kinds of sand and clay, and then hardpan, which is so hard that it has to be loosened with a pick. On this again is a sticky clay, with an increasing amount of water towards the top, and above this there is occasionally quicksand. For the buildings erected directly after the fire of 1871 the foundations were sunk usually about 12 ft. below grade, and built up with rubble masonry, but in some of the larger buildings of 1882 to 1884 concrete was used for footings reinforced by steel rails or I-beams. The former were first used in the Rookery Building and the latter in the Tacoma Building. Combinations of rails and beams were also used. This system required much less depth of footing than where stone was used. The Fair Building was the first in which the top crust of hard clay was penetrated, the foundations going to a depth of 14 ft. in order to give a high basement, although this was generally considered a dangerous proceeding. At the north end of the Monadnock Building the foundations were sunk through an old slough to a depth of 17 ft. below the sidewalk. When the Masonic Temple was built Gen. Sooy Smith proposed the use of caissons and piers, but the plan was not thought feasible. He finally succeeded in having this plan used in the Stock Exchange Building, but it is only very recently that it has been generally adopted. Wooden piling is little used for buildings, and only where there is no danger from surrounding buildings. Concrete piling has been recently used for several buildings.

Tests with tanks filled with water and resting on [illegible] clay have shown a settlement of 5 to 8 ins. in four months, with a load of 3,000 lbs. per sq. ft. It has therefore been general practice to set the buildings on about 5 ins. where this load is imposed, or 8 ins. where (as in the Monadnock Block) the load had to be increased to 3,300 lbs. The Monadnock Block has settled more than the 8 ins. allowed for. The allowance to be made is a matter of judgment in each case. The Fair Building was designed to be 10 or 12 stories high, and was set up about 9 ins.; it has never been built to full height and has not settled as intended, so that the sidewalk has a steep slope to the curb. The Majestic Theater Building (built in 1904) was set up 5 ins., but was built higher than intended and has settled 10 ins., requiring an adjustment of the sidewalk.

In Illinois the case has never been tried as to how far an owner must take care of neighboring buildings. Some lawyers hold that where proper methods and men are employed, and the owner is shown to have used all precautions, he is not responsible for damage. Others hold that he is responsible for anything that happens to the adjoining building, and must repair cracks, redecorate, etc. In New York the owner must take care of his neighbor. There are great difficulties in building deep foundations alongside old structures founded upon the top crust of clay which is underlaid by soft material or quicksand. The party-wall question is sometimes very serious, and the Rand-McNally Building was the first in which cantilever girders were used to carry the party wall, so as not to sink any foundations under the wall. They were used also in the Champlain Building, and more recently in the Heyworth Building (which has 15 or 16) and the Thomas Orchestra Building, but their use is not common.

The most interesting foundation to-day is the so-called caisson system, but it has not yet been found necessary to use the compressed air system. In this method the excavation is made about 5 ft. deep and lined with wood lagging braced by steel rings inside. The rings are about ½-in. thick, 4 or 5 ins. deep, and about 3½ ft. apart. Then the excavation is put down 5 ft. further and again lined, and so on to the desired depth. There is room for improvement in this method, and the matter is receiving the attention of engineers. Settlement may occur from the fact that the excavation cannot be made to an exact cylindrical form, and any voids outside the lagging may be filled by movement of the clay. In some cases steel interlocking piling has been put down to form a lagging for the entire depth before excavation is commenced. The caissons are usually 5 or 6 ft. diameter, but some of 9 and 10 ft. have been sunk, while the largest yet used is 12 ft. diameter. It would seem that many of these are too large, but 4 ft. is the minimum size in which a man could work. There is sometimes danger from gas collecting in the caisson. In 75% of the buildings the caissons are only sunk to hardpan, instead of rock; in these cases the bottom of the caisson is enlarged to give a large bearing surface. The lagging and rings are sometimes removed

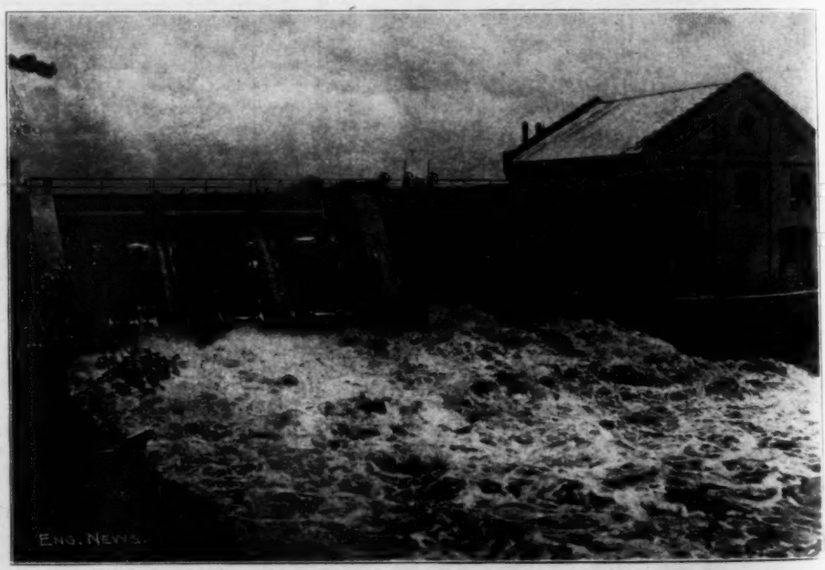


FIG. 4. DOWN-STREAM SIDE OF RIVERDALE DAM AND POWER STATION.

...s the concrete is filled in, and sometimes left in place. Whether the excavation could be done by machinery is a question.

Three basements are now very common and plans ...ave been made for a building with eight basements, fac... on a great central court. The basement depth is 33 ... for the Tribune Building, 40 ft. for the Heyworth

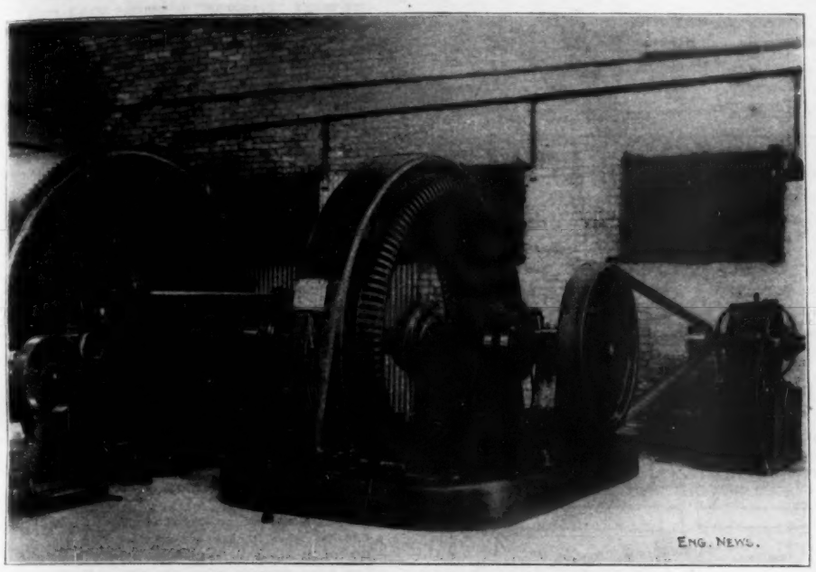


FIG. 5. ONE OF THE GENERATING UNITS IN THE RIVERDALE POWER STATION OF THE APPLE RIVER POWER CO.

...building, and 51 ft. in another building. It seems probable that all buildings with spread or shallow foundations will eventually have to be put on pier foundations, and some owners are already figuring on this.

The whole question is very important, and engineers should read the technical papers constantly, as these very frequently have matters of interest in regard to foundations.

TOWERS FOR CARRYING ELECTRIC POWER TRANSMISSION WIRES AT SACRAMENTO, ACROSS THE SACRAMENTO RIVER, CAL.

By J. D. Galloway.*

There is shown herewith details of two towers erected at Sacramento, Cal., for carrying electric power transmission lines across the river at that point. They were built under the direction of the writer and are a part of a line from Sacramento to Davis. The distance between towers is about 1,400 ft., and the lowest wire is 85 ft. above high water in the river. The normal deflection of the wires is 40 ft., with a possible variation of about 3½ ft. either way. The wires are aluminum cable of 360,000 circular mils area, and the allowed static stress is about 2,000 lbs., giving a safety factor of about five. Owing to right of way difficulties, the wire could not be carried away from the towers in a direct line, so that the frame was calculated to stand the direct pull of the wires without help from the wires on the opposite side.

The general design of the towers is shown by the view, Fig. 1, and the details of its construction, including the platforms and insulators, by Fig. 2. The steel tower is 142 ft. high and the top platform extends slightly above that. The corner posts have the same cross-section from top to bottom, being composed of two 8 × 13¾-in. channels, latticed together as shown. The four intermediate posts (see Fig. 1) and all the horizontal members except those in the platform portion of the tower, are composed of four 3 × 2½ × ¼-in. angles, also latticed together. The tie rods range in diameter from 1¼ ins. at the bottom to ¾-in. at the top. The base of the tower is 59½ × 50½ ft. in plan. The top dimensions are shown by Fig. 2.

ELECTRIC MOTORS connected to the supply mains of the New York Edison Co. on Manhattan Island passed the 100,000 HP. mark on Aug. 31, 1905. It will be noted that this includes no portion of the Borough of Brooklyn, which is served by the Brooklyn Edison Co.

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SOME HYDRAULIC TESTS ON THE FLUME OF THE PUGET SOUND POWER CO.

The plant of the above-named company, near Tacoma, Wash. was described and illustrated in Engineering News of Sept. 29, 1904. The water supply is carried from the head inlet to the reservoir in a rectangular wooden flume 10 miles in length. Another paper describing this plant was contributed to the American Society of Civil Engineers by Mr. Edwin H. Warner, M. Am. Soc. C. E., and was printed in the May "Proceedings." A discussion of that paper in the September "Proceedings" of that Society by Mr. Jos. H. Cunningham, M. Am. Soc. C. E., reports some hydraulic tests on this flume, and gives additional data respecting its construction. Mr. Cunningham was a member of the engineering staff employed on this work, and as very few hydraulic tests of long timber flumes have been made, we reprint here the substance of Mr. Cunningham's contribution:

Mr. Warner's description of this plant is most interesting, and, as a whole, quite accurate. There are some points of minor importance, however, which are not correctly stated—the final dimensions of the flume, for instance. It was the original intention to finish all members to the sizes shown on the plans, but, owing to the fact that this was not stated in the Chief Engineer's specifications, the finished pieces were from ¼-in. to 1 in. less.

The flume sills were double members, dressed on two sides, 3¾ by 7¾ ins. by 15 ft. long, bolted to posts with ⅝ by 15½-in. wrought-iron bolts, with cast-iron washers. The posts, dressed on two sides, were 5¾ ins. square by 9 ft. long, and spaced at 4-ft. centers. The beams were 5¾ ins. square and 10 ft. 6 ins. long, and were gained ¾-in. and spiked to the posts with one 10-in. wire spike. The sides of the flume were 2¼ by 11-in. tongued and grooved stuff, dressed on the inner surface. The bottom was double, the outer plank being 1¾ in. thick, and dressed on the outer side, and the inner plank being ¾ in. thick, and dressed on the inner side. At the junction of the sides and bottom a chock, 2½ in. square, was used to confine a 7-in. strip of three-ply tar-paper, which extended between the bottom outer and inner floors. This arrangement was quite effective in stopping leaks. Within five days after the water had been turned into the flume, the leakage amounted to a trifle less than 1% of the total discharge.

The bottom was sawed to a true curve, the transverse joints of the upper and lower floors being 18 in. apart, and considerable care was used to break joints longitudinally. No difficulty was experienced in bending the side planks to the sharpest curve, and, considering the fact that lumber was purchased from a dozen different mills, and that much of it was imperfectly sized, and, also, that all work above the stringers was done by contract, the flume is remarkably tight and well built.

As the country was too rough to admit of building a wagon road within less than ¼ to ½ mile of the flume line, a standard-gage railway was laid over the lower 8 miles, and all lumber above the cape was delivered by rail.

Eventually, the flume will be 8 ft. wide and 8 ft. deep. At present the depth is only 4 ft. 4¼ in., and is intended to carry water to a maximum depth of 4 ft. The upper 548 ft. is built on a grade of S = 0.0093, or 1:254; on the following 1,051 ft., S = 0.0029, or 1:340. On the remainder of the line, 51,940 ft. in length, S = 0.001366, or 1:733. The latter grade was intended to be used on the entire line, but, owing to a change in the location of the intake after work had been started on the flume, a broken grade had to be used. The greater portion of the flume was located on a very steep hillside, the average slope on fully half the line being greater than 50 degrees.

Owing to the difficulty and expense of building a wagon road near the flume line, it was decided to use the timber on the ground for trestle caps, posts, sills and mud-sills. All the mud-sills were of cedar; other members were of fir, hemlock and cedar. Drift-bolts and nails were delivered by wagon as near as possible to the flume, and then carried by pack-horses and men. Trestle bents were held upright by braces of light poles. Crabs were used for erecting bents on portions of the line, these sliding over bents previously erected. These, however, did not prove successful on all parts of the line, and, where the trestles were low, better progress was made with gin-poles.

As the ground throughout this region has a strong ten-

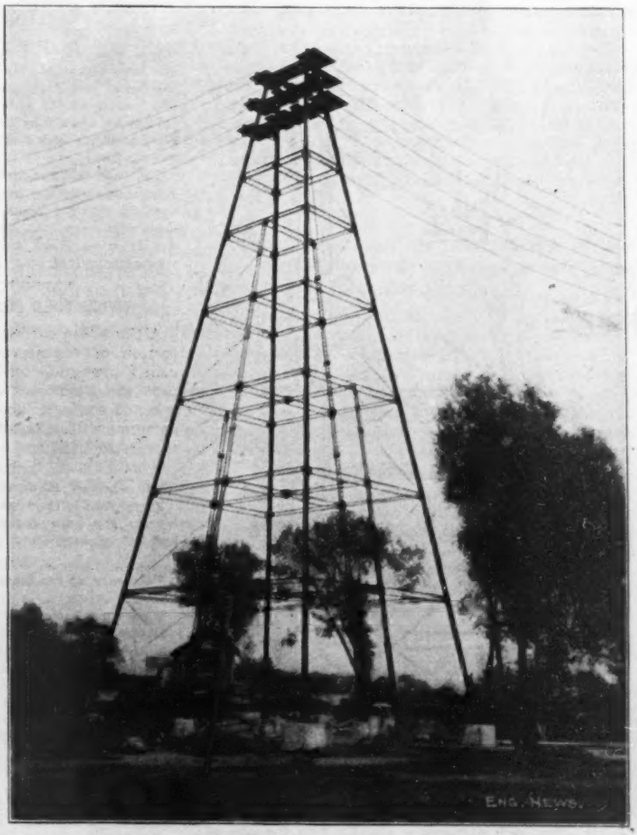

FIG. 1. GENERAL VIEW OF TOWER FOR CARRYING ELECTRIC POWER WIRES ACROSS THE SACRAMENTO RIVER, AT SACRAMENTO, CAL.

dency to slide when disturbed, it was sought to avoid all side-hill cuts as much as possible, and place the flume on a cripple-bent trestle for practically the entire length.

In establishing the gradient of the flume, the friction factor, n, in Kutter's formula, was assumed at 0.0105, in order to cover defective lumber and workmanship. After the flume was completed and water was turned in, the writer made a series of experiments, the results of which are shown in the accompanying table.

The mean friction coefficient, n, for dressed lumber, from the table, is 0.00962, and it will be noticed that in nearly every case n increases slightly with the size of the slope, S, also with the hydraulic radius, where S is constant. The velocities were measured with a Price current meter, No. 131, at two stations 1,000 ft. apart. The observations taken on the same date were made when the depth was constant. The values of the coefficient, C, in Kutter's formula, $V = C\sqrt{RS}$, were deduced from the mean velocities, and the values of the friction factor, n, were taken from the diagram prepared by Messrs. Hering and Trautwine. No measurements were made on the lower grade of the flume, for the reason that at this time it was not quite finished at the lower end. Assuming a friction factor of 0.010 for the lower grade of S = 0.001366, the carrying capacity of this flume when running 7 ft. deep will be 576 cu. ft. per sec., and, for the present development, 4 ft. deep, 284 cu. ft. per sec.

The time required to complete the flume, including the trestle substructure, was 7½ months. The trestling and grading required about 4 months, and was by far the most expensive, not for the reason that it was done by day labor so much as on account of difficulties in the transportation of materials, supplies, etc.

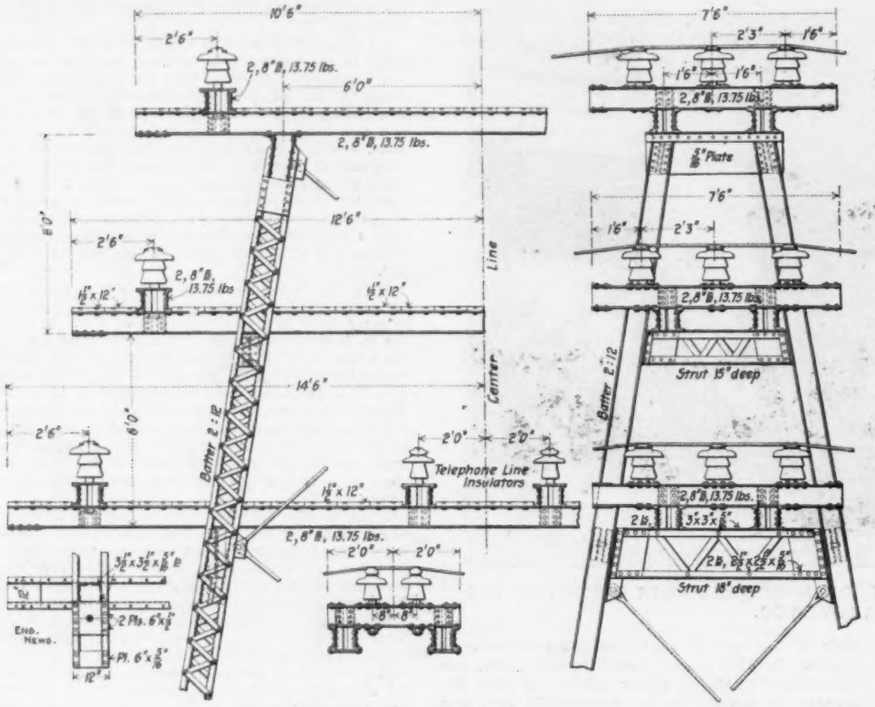

FIG. 2. DETAILS OF ELECTRIC WIRE RIVER TOWER, SACRAMENTO, CAL.

TWICE TOLD PROVERBS FOR ENGINEERS.

A Canadian correspondent forwards to us a collection of engineering proverbs which were recently presented by "Mr. E. C. Easy, C. E.," before the Engineers' Club of Toronto. We have selected some of the best of these proverbs which combine with a familiarity of form an undeniable "truth to life" and reprint them as follows:

TRIAL LINES.

The engineer is worthy of a higher hire.
Every man is the engineer of his own fortune.
Some are born engineers, some achieve their C. E., and others have their civility hammered into them.

FIELD NOTES.

Take care of the fence, and the bull will take care of himself.
Where much choke is, there must be some smudge.
Happy is the bridge that the paint shines on.
A bad bolt is soon sheared.
A double track is worth a carload of switch[illegible].
Bad cross-hairs corrupt good manners.
Assume a bench-mark if you have it not.
All is not Polaris that glitters.
Spare the rod and spoil the profile.
There's many a slip 'twixt the sight and the [illegible].
A transitman's wave is as good as his word.
One man's "Trautwine" is another man's mea[illegible].
Swift drains the water where the sewer is dee[illegible].

OFFICE WORK.

Measure in haste and repent in the office.
A night in the town is worth two hundred in the [illegible]ash.
A steep grade is rather to be chosen than great l[illegible]ss.
The lawsuit oft proclaims the contractor.
A good rubber turneth away wrath.
The better the description, the better the deed.
What is missed in the tracing will not come out [illegible] the blueprint.
There's no use coloring over spilt ink.
It's a poor scale that won't read both ways.
Faint ink never won fair blue-print.
Too many cooks spoil the plot.
It's a poor adder that won't carry his own figure from the last column.
As ye make your bill, sae maun ye lie on't.

BY-PRODUCTS.

A rolling stone gathers no cement.
All are not mines that investors bite at.
Fine sand betters no concrete.
One layer of expanded metal makes the whole concrete kin.
A touch from a live wire is a breakfast for a coroner.
Reforestation is the first aid to Nature.
If straps were seats, beggars would ride.
A survey goeth before construction, and a power plant before a fall.
Too much anchor-ice breeds lament.
The flat wheel makes the greatest sound.
It's an ill explosive that blows nobody up.
The promoters flee when no cash pursueth.

THE NEW ELECTRIC LOCOMOTIVES for the Metropolitan Ry. (underground), of London, England, weigh 150 tons and can haul trains of 170 tons (exclusive of the locomotive) at 36 miles an hour, and 250 tons at 27 miles an hour. They will haul local passenger trains and will also haul freight trains from main lines to the underground stations serving the city freight terminals. The motors are of the street railway type, ventilated by jets of air at 4 ounces pressure. There are four motors of 200 HP., capable of working at 250 HP., and each pair has a separate controller, the controllers being operated by a single master-switch. The length over end sills is 32 ft. 3 ins., while the total length over the spring buffers is 35 ft. 9 ins. At the middle is the cab, 11 ft. 6 ins. long, with a total height of 12 ft. 3½ ins., and at each end of this are steel casings enclosing the brake pumps, controllers and other apparatus. The locomotive is mounted on two four-wheel trucks, the truck wheelbase being 7 ft. 6 ins. and the total wheelbase 24 ft. 9 ins. Ten of these locomotives have been built by the British Westinghouse Electric Co.

A DIVING BELL OF 4,000 YEARS AGO is noted by Mr. Cope Whitehouse, in a communication to the "New York Sun" of Oct. 1. Mr. Whitehouse is the owner of a small volume published in Paris in 1683 and containing a preface by Pierre Vattier, Professor of Arabic in the University of Paris. The purpose of the volume was to induce Louis XIV. to take Egypt under his protection; and it contains among other things a translation of an Arabic manuscript compiled in the fifteenth century by one Murtadi ibn Gaphiphe. This writer describes the building of Canopus, a seaport once lying to the east of Alexandria. He goes on to say that "according to tradition" great difficulty was experienced in building the breakwater and jetties; and a "sea nymph" is credited with recommending the construction of a "vessel of glass large enough to contain several draftsmen, with a supply of materials and food." This vessel was to be lowered to the bottom of the sea, where the draftsmen were to sketch the marine monsters supposed to be responsible for tearing down the stone blocks as these were deposited. The "nymph" also advises the installation of a rope with a bell attached, so that the men could ring when they wanted to ascend. Mr. Whitehouse dates the original story about B. C. 1900.

EXPERIMENTS ON THE HYDRAULICS OF THE TIMBER FLUME.

Date, 1903.	Section.	Depth in Feet.	Hydraulic Gradient, "S."	Hydraulic Radius, "R."	Mean Velocity "V."	Friction Coefficient "n."	Coefficient, "C."	Discharge, Cu. Ft. per Second.
December 15.....	1	2.67	0.00393	1.60	13.5	0.0098	170.6	288.0
" 18.....	1	2.44	0.00393	1.51	13.22	0.0097	171.9	258.3
" 18.....	2	2.60	0.00294	1.57	12.03	0.0095	178.0	250.2
" 19.....	1	3.28	0.00393	1.79	14.27	0.0100	170.0	389.0
" 19.....	2	3.45	0.00294	1.85	13.28	0.0095	180.0	365.6
" 20.....	1	1.33	0.00393	1.00	10.76	0.0093	171.0	113.9
" 20.....	2	1.42	0.00294	1.05	9.78	0.0090	176.2	114.2
" 22.....	1	3.25	0.00393	1.79	14.55	0.0098	173.3	378.8
" 22.....	2	3.55	0.00294	1.88	13.45	0.0095	181.0	382.2
" 24.....	1	2.85	0.00393	1.66	14.08	0.0097	174.3	321.8
" 24.....	2	3.15	0.00294	1.76	12.08	0.0100	167.9	322.9

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ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See pages 26 and 27.

Copy for regular, or "Contract," Advertisements should be received one week before publication; "For Sale" and "Situations Wanted" Advertisements by Tuesday, and "Proposal" and "Situations Open" Advertisements by 11 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

The fire insurance companies have a big club with which they hit water-works men over the shoulders of their policy-holders. It is known as the Pink Slip. When this slip begins to appear on fire insurance policies those locally in charge of the water-works know that something more than explanations will be demanded of them; in other words, public opinion will demand, if not compel, improvements or extensions to the water-works.

The following is a copy of a Pink Slip recently attached to a $5,000 policy at Buffalo, N. Y.:

THE BUFFALO ASSOCIATION OF FIRE UNDERWRITERS.

Explanatory Note to Policy Holder.

Special Charges for Serious Defects in the Protective Facilities of Buffalo: $17.50 of the premium of this policy represents charges for the following defects and deficiencies in the local facilities for fire extinguishment and for certain unguarded hazards. This premium is computed on the basis of an increase of the schedule rate of insurance of 35% (not exceeding 35 cts. per $100 of insurance), in this proportion:

(1) Pumping station deficient in construction and equipment	$ .18
(2) Hazardous condition of same	.02
(3) No duplicate pumping station and intake	.07
(4) Fire alarm station in present condition	.02
(5) Wiring not underground	.02
(6) Insufficient fire department equipment	.02
(7) Undersized water mains	.02
	$ .35

Note.—When the pipe line system is supplied with an approved independent pumping station, a specific allowance will be made upon the risks under pipe line protection.

In its issue for September, "The Buffalo Manufacturer" publishes a statement by a "committee" of three criticising the insurance companies and their agents for this advance in rates, and urging that the advance is based on sinister motives. We have no reason for taking sides in the controversy, and shall not do so. The apparent underlying reasons for the advance are plausible, and some if not most of the arguments advanced by the committee in confutation are decidedly weak: such as that the mains are as large now as they ever were, and that "within the knowledge of the committee there has never been a fire occasioned by any one of the seven items denominated by the association as 'Defects.'" Our purpose in mentioning the Buffalo incident is to call attention to the fact that with the better organization of the insurance interests, and especially of their engineering departments, which prevails now as compared with former years, it may be expected that the ever-ready Pink Slip club will be wielded more frequently and vigorously than ever before. It is a pity that the life insurance companies cannot adopt a Yellow Slip, and force backward communities to make improvements in the sanitary condition of their water supplies. Between the fire and the life companies the country would soon be dotted with model water-works.

Railway terminals is certainly a fit subject for study. We are pleased to note that it is one of the topics scheduled for the new four-year course in railway education at the University of Chicago, noted in our issue of Sept. 27. We trust the broader civic and aesthetic phases of the subject will not be overlooked. Some of these have been ably and interestingly discussed in Charles Mulford Robinson's "Modern Civic Art," a second edition of which was noticed in our Engineering Literature Supplement for April 13, 1905. The city railway terminal or urban railway station in general is the great gateway of the modern city. Therefore both in convenience to the public and in artistic qualities its importance and its possibilities should be recognized. This is a fit subject for the concern of city authorities and for engineering and architectural societies as well as for the railway managers.

The proposal to raise the level of Lake Erie by a controlling dam at the head of the Niagara River is being vigorously opposed, according to the New York "Tribune," by the engineers of all the electric power companies at Niagara Falls, "on the assumption that the damming of the river would result in a diminished flow at the Falls."

We are curious to learn on what ground that remarkable assumption rests. A dam that could permanently reduce the volume of flow of a river would be a notable curiosity, entitled to rank with the seven wonders of the world. Of course, if a stream can be diverted by a dam, the case is different; but at Niagara no such diversion is possible. All the water that flows into Lake Erie (barring loss by evaporation) must flow down the Niagara River, and a dam 1 ft. high or 20 ft. high across the outlet of Lake Erie would make in the long run no difference in the volume of flow.

It may be said that the Niagara power companies are protesting against the temporary reduction in the river's flow, while the level of Lake Erie is being raised. As a matter of fact, however, the period of time required to build a submerged dam across the head of the Niagara River would be great enough to distribute the temporary reduction in the outflow over so long a period that its effect would probably be undiscoverable. The diurnal variations in the flow of the river due to the changing winds on Lake Erie are far greater, doubtless, than any temporary reduction that a dam could effect.

There remains the interesting question whether these diurnal variations of flow due to the winds would be greater or less with the water flowing out of the lake over a submerged dam than at present with the water flowing in the natural channel. If these variations were increased, the power companies would have ground for opposition; but it is not apparent why there should be any increase.

A very interesting idea respecting the design of shops and manufacturing plants was put forward by Mr. Alex. E. Brown, of the Brown Hoisting Machinery Co., in an informal address before the American Society of Civil Engineers at the Cleveland meeting last summer. Mr. Brown was referring to the new works of his company, built in 1902, which the Society was to visit on the following day, and explained their design as follows:

> At present the main building consists of one large room. We abandoned the idea of trying to stretch out in one long building, commencing work at one end and finishing at the other. That method, I am satisfied, is obsolete for most places; a building is wanted only as a cover and a place to support overhead cranes, the closer you can get to your management in a building the better. If it were made in one long stretch it would be more than 3,000 ft. long, taking all the buildings. Our main building would be 2,500 ft. long and 71 ft. wide. Imagine the supervision required in having to start from one end and walk half a mile to give an order. At present it is 700 ft. front by 312 ft. deep, and is under one roof. The foreman is rarely more than 250 ft. from any one he wishes to talk with, for his central office is not more than 300 ft. from the farthest point of the building. This compact method lends itself to the machine shop, the structural shop and to the assembling between the two, in such a way that all the materials go the least possible distance, with the least possible handling and supervision, to their final loading on the cars. This construction also leaves the building without partitions and without obstructions, free for future changes which we cannot anticipate—which is so much appreciated in this country—it isn't added to and taken from every time you wish to do a new piece of work. It is left a simple open area with a cover; that is the structure of our building.

The "long drawn out" design of shop construction has had many advocates, and for certain classes of work, where material can be taken in at one end and go out in finished form at the other, it has undeniable advantages. But for a machine building establishment such as that of the Brown company, the square building would appear to be undeniably superior. Besides the great advantages pointed out in the above quotation, it will be evident that the square building gives the maximum area enclosed with the least expense for enclosing walls and the least loss of heat through them, an important matter in severe climates.

On the other hand, protection against fire is best secured by a number of independent isolated buildings rather than one large building. Lighting and ventilation are more easily secured in buildings of moderate size. The isolation of foundries and smith shops from machine shops, at least by separating walls, is necessary to keep dust, smoke and grit away from valuable machines; and pattern-shops and other wood working shops and processes using oils, paint, varnish, etc., must all be isolated to reduce danger from fire.

Of course, the majority of manufacturing plants are not designed; but like Topsy, "just growed." They are added to bit by bit as the business develops. It is important, however, that the principles of correct design should be understood, and that additions should be made with a view to the best ultimate results.

The paper by Mr. Richard L. Humphrey, published in our issue of Sept. 21, describing the results of the tests of cement and concrete made at the St. Louis Exposition, was prepared by Mr. Humphrey for the Association of American Portland Cement Manufacturers and the American Society for Testing Materials. Through a misunderstanding on the part of the editors of this journal, credit to these societies was omitted in the publication of Mr. Humphrey's paper. It is the invariable policy of Engineering News to give due credit to the original sources, for all matter published in its columns, and we take pleasure in giving prominence to the correction of our error in this case.

PUBLIC OWNERSHIP OF TELEPHONES IN GREAT BRITAIN AND THE NEED FOR PUBLIC REGULATION IN THE UNITED STATES.

Some reflections on public ownership of telephones and upon competition in the telephone business are suggested by recent happenings in Great Britain and in New York City. These happenings are the prospective full ownership of telephones by the British Post Office and the application for franchises made by four telephone companies in New York City.

As some of our readers may be aware, private ownership of telephones in Great Britain will be terminated in December, 1911, when the Post Office will add to its trunk lines and its London exchange all the plant of the National Telephone Co. This is in accordance with an agreement between the Post Office and the National Telephone Co., made last February, and ratified by the House of Commons in August. The national government will obtain nearly all the plant of the company at its actual present value, with no allowance for good will, except in the case of the private line business and a few exchanges where the licenses extend beyond 1911. The Post Office has cancelled the seven licenses already granted and not acted upon by municipalities, and has given notice that the licenses for the five municipal plants now in operation will not be renewed at the time of their expiration in 1911.

The apparently excellent bargain that the Post

Office has concluded with the National Telephone Co. is due to the fact that it retained to itself from the outset the control of the whole telephone situation, first by limiting the main license of the company to 25 years and second by building and operating trunk lines itself. In what measure, if any, this has retarded the development of the British telephone system in extent and efficiency is too large a question for discussion here. The National Telephone Co. knew from the start what it might expect in 1911 and doubtless cut its coat accordingly. The Post Office, acting as it believed in the interest of the public, paved the way for full ownership and control of the telephone in 1911, and that at a price which seems to be generally regarded as fair and reasonable to both parties. If, then, anyone has suffered from the short-term franchise it has been telephone subscribers, who possibly, though by no means certainly, might have had a better service during the last ten or a dozen years of the license had the company not been facing the probable surrender of its business to the government in 1911. If there has been any deficiency in service on this account it has been confined to a very few years, and it lies with the Post Office to make it more than good when the era of public ownership begins six years hence. Of course it may be argued that under public ownership the service, previously hampered by the prospect of government purchase, will deteriorate rather than improve, and also that the looked-for reduction in rates will result in further Post Office deficits and a shifting of a part of the cost of the service from telephone subscribers to general taxpayers. This we need not discuss, since under present American conditions serious talk of public ownership of telephones is not likely to arise. We, therefore, pass on to a phase of the subject which directly concerns many sections of the country and which, as already stated, has recently come to the front in New York City, namely, telephone competition.

Whatever opinion one may hold regarding the relative advantages of public and private ownership of telephones it is obvious that the best service demands a single highly centralized system, rigidly controlled by the public, in the matter of service rendered and rates charged. Attempts at telephone competition might possibly be warranted in municipalities which had foolishly neglected to retain control, and in which honest and intelligent efforts to secure a readjustment of rates and an improvement in service had met with no response from the existing companies. But even under such circumstances the benefits of competition are liable to be more apparent than real. A new company might compel an old one to reduce its rates by one-half, but it can rarely if ever drive an old company out of business; failing in this it becomes necessary for those who wish a comprehensive telephone service to provide themselves with two telephones. This generally means higher total charges than were paid before to the old company, and in addition the great nuisance of two telephones. The streets are also needlessly encumbered, above or beneath, with the duplicate line system, and altogether there is a waste of good money on the part of the competing telephone companies and a loss of money and time on the part of the telephone subscribers.

Any city that admits a competing telephone company thereby confesses either past folly or present weakness; folly in not surrounding its previous telephone franchise with proper conditions for regulating charges and character of service; or else weakness in not holding the existing company to terms. Not infrequently both folly and weakness are involved.

Thus far we have considered attempts at telephone competition from the purely local viewpoint. With the rapid increase in long-distance service competing lines become an ever increasing hindrance to the transaction of business.

It is time for the American public to realize the telephone situation and to seek improvement of the service by unifying instead of dividing. If lower rates are justly due then an attempt should be made to secure them by amicable agreement with the existing company instead of by cut-throat competition.* In the water and gas service attempts at competition have been practically given up; in fact, such attempts in the water-works field have been few. In the electric service there are still many pretexts of competition, but few instances where it is really being maintained without unhappy consequences to all concerned. Street railway competition is also virtually a thing of the past. In all these fields it is well recognized by capitalists and by the most intelligent portion of the public that competition is impossible under present conditions and that even if possible it is economically unsound.

If all this is true of the city water, lighting and transportation services, how much more is it true of telephones? Most of the arguments against competition in these fields apply with equal force to the telephone service, but in addition there is a potent reason against competing telephones which does not apply to competition in any of the other services. It makes no difference to the individual patron of a water-works, lighting or street railway system whether he is one of a few or many who patronize that system, except in so far as full patronage may help to lower the charges, but the value of the telephone to every subscriber is in proportion to the number of subscribers. Perhaps it is going too far to say that the ideal telephone service would enable a subscriber to talk with every person in his own and near-by municipalities and with at least the leading business and professional men throughout a wide range of country, but it is true that the more extensive the service the more valuable it becomes. This will be better appreciated as time goes on and the service becomes more general and, as it is bound to do, indispensable. With the inevitable great increase in the number of telephones, duplicate and triplicate systems will become more and more burdensome.

Since it is inevitable that the American telephone service will eventually be unified, and since there is no likelihood here of emulation of the British Post Office in assuming ownership of the telephone, there is all the greater reason for public control in America than there was in Great Britain when it granted its 25-year license in 1886. How this control is to be achieved under our complex conditions of national, state and municipal government we are not prepared to say. The problem should be faced at once by at least the state and local governments. The fetish of competition should be abandoned once for all, in this and many other branches of the public service, and in its place a strong, competent and honest public regulation of a recognized natural monopoly should be established.

In conclusion, we wish to point out what has doubtless occurred to many but is far from being realized by all: The very life of modern business and foundation of our present civilization is certain, cheap and speedy means of verbal communication. The whole world has long recognized the necessity of certain and cheap verbal communication by providing extensive and often elaborate postal facilities, and has devoted vast energy and expense to increase the speed of the post. Many countries have added the time-saving telegraph and some the more speedy telephone to the means of verbal communication offered the public. The United States has postal facilities which in many respects are unsurpassed by any nation, but neither our national or our state governments have recognized their duty to the public in the matter of the telegraph and the telephone. We do not argue for public ownership of these necessities, but a greater public control than has yet been more than dreamed of is due the people of this country.

In the case of the telephone, a little has been done and much more might be done in the way of municipal regulation, but in many respects our cities are now as little able to cope with telephone companies as with the far-reaching interurban street railway companies. In short, our municipal public service companies must hereafter be controlled by the several states and our interstate companies for the transmission of news, goods and verbal intelligence by the states and the central government, subject of course to a proper degree of municipal regulation in local matters. The telephone has far outstripped the telegraph for all but long-distance business, and, up to the physical limits thus far attained by the telephone, even for the most urgent long-distance messages. In a few years the telephone will be found in practically every residence save the poorest, as it is already in practically all business houses, while eventually the potential long-distance service will be limited only by the boundaries of the continent. Competition will then be an impossibility and public control an absolute necessity.

*The recent creditable cooperation of the New York Merchants' Association and the New York Telephone Co. in the matter of rate readjustment was discussed briefly in our issue of March 30, 1905. An interesting and valuable report on the investigation which led to a lowering of the New York rates has since been made public by the Merchants' Association (346 Broadway, New York City).

LETTERS TO THE EDITOR.

Economy of Gas Producer Plants Where Heating is Necessary.

Sir: I notice in your issue of Sept. 7 an article by Mr. J. H. Kinealy on the relative economy of gas producer and non-condensing engine installations in situations where a large amount of heating is necessary. I think one statement of Mr. Kinealy's is slightly misleading, viz., that when the steam required for heating is more than that required for power the engine simply acts as a reducing valve and the fuel required is only that necessary for heating.

This would be true if it did not take fuel to raise the pressure of steam from the pressure used for heating to that used for the engine, but unfortunately this does take fuel and although the amount is small (perhaps 4% of the total) it should be taken into account or at least mentioned so as not to be misleading to those not thoroughly familiar with such computations.

Mr. Kinealy has also neglected the heat removed by the cooling water from the jackets of the gas engine and which may be used in a suitably designed system for heating and is of considerable amount.

Yours very truly,

Geo. W Jeffery.

Malden, Mass., Oct. 2, 1905.

The Loose Leaf System for Estimate Sheets.

Sir: In commercial circles the loose leaf system of keeping accounts is largely in use, and is rapidly gaining favor every day.

I write to ask to what extent this system is in use among engineers in recording estimates. The system generally in use for this work is to combine on one large sheet all and every item entering into the estimate, which is then folded and placed in filing boxes.

It may not generally be known that the standard sizes of blank forms are multiples of $3\frac{1}{2} \times 8\frac{1}{2}$ ins., the usual sizes being $7 \times 8\frac{1}{2}$, $10\frac{1}{2} \times 8\frac{1}{2}$, $14 \times 8\frac{1}{2}$ ins., etc.

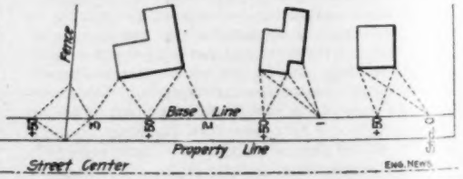
It has occurred to me, instead of using these large sizes for estimate blanks, it would be well to use a size, say $8\frac{1}{2} \times 10\frac{1}{2}$ ins., which is the usual voucher size, and also conforms closely to the usual letter size. Instead of placing all kinds of work on one sheet, each item would be kept separate, such as masonry, excavation, crib work, clearing, etc. The blanks to have a margin on the left-hand side or edge, about one inch wide, and printed in copying ink, on one side only. When made out in copying ink they can be readily copied, and a number of impressions made. The original estimate sheets would be kept flat, in a suitable binder, and are thus readily accessible and easily referred to.

Yours truly, "E. N. Jinear."

Pittsburg, Pa., October 2, 1905.

Surveys for Mapping the Location of Buildings on City Streets.

Sir: Replying to T. R. Ansit's request for suggestions as to the method of locating houses along a city street, I herewith hand you a rough sketch of a method requiring a tape line or chain, only, which I have employed for a long time with very satisfactory results. The method is



especially appreciated in the drafting room where the use of a protractor is not always accurate or rapid. The setting up of a transit at convenient pluses on a given base line for the purpose of reading angles to each house seems to me to consume an unnecessary amount of time

and leave many opportunities for errors. The use of the plane table also has this objection of lost time.

The location of the base line should depend entirely upon the existing condition; whether it be located in the center of the street, along the curb line, inside of the front yards or in the rear of the buildings. The use of only 50-ft. pluses reduces possible errors in chain reading arising in the method of sighting in the side of a building upon the base line and then reading the distance to the corner from this point.

As shown by the sketch, the intersection of two distances from given points is bound to be the third corner of a triangle and there is no possibility of misplacing the corner measured too.

The measurements taken from Stations 3 and 3 + 50 on the right show the method applied to the location of the line of direction of a fence.

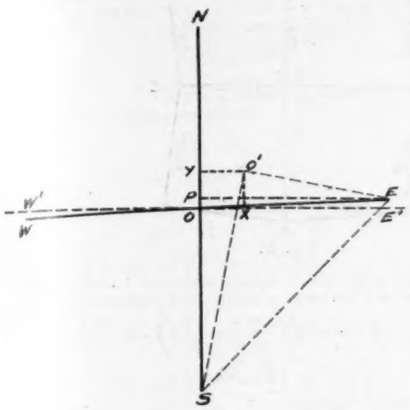


Fig. 1.

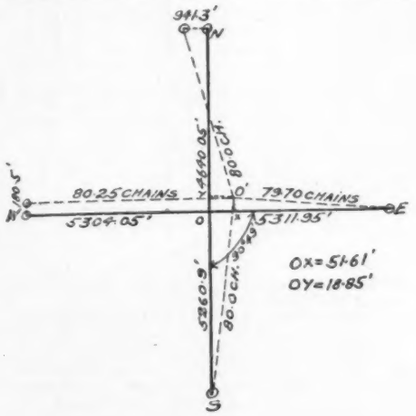


Fig. 2.

I found this to be especially satisfactory in the recent mapping of the grounds of the State Capitol in this city, where I had to locate every tree in the ground as well as the buildings, fences, monuments, poles, etc.

Yours truly, S. E. Washburn,
County Engineer, Montgomery County.

Montgomery, Ala., Sept. 23, 1905.

Tightening Rivets by Calking or Sledging.

Sir: In your last issue (Oct. 5, 1905) a subscriber puts the question (p. 357): Is it permissible to calk or sledge loose rivets in structural steel work?

As rivets are supposedly subjected to shearing stress only, they can only fulfill their function when their bodies fill the holes in the plates or shapes through which they pass, completely. The rivets shown in the illustrations do not fill the holes and hence these rivets cannot fulfill their function properly.

Calking or sledging the edges of the rivet heads does not cause the metal of the bodies of the rivets to flow down into and fill the holes, and hence is of no benefit. In fact, this does not tighten the rivets, for if they be tapped on opposite sides after calking they will be just as loose as originally. Nothing can be done to make a loose rivet tight; it should be cut out and another filling the hole should be driven in its place.

The statements of the superintendent that calking is up to the best practice in eastern shops and that the strength of columns is in no wise impaired are contrary to facts and universally condemned. His statements are merely excuses for bad work in his own shop.

The proper manner of obtaining tight rivets in every case, whether driven by hand or by power, is to heat the rivets much hotter at the head than at the end which is to be upset. When such a rivet is driven, it will swell first under the head and the metal will gradually swell from the head out toward the set until the entire hole is filled. A rivet thus driven will always be tight and also form a good head and will never require any doctoring. When rivets thus heated are driven by power, the riveter need not remain on the rivet until cooled off. This method of heating rivets produces particularly good results in the field when rivets are driven by hand.

Yours truly, Gus. C. Henning.

Consulting Engineer, 150 Nassau St., New York, N. Y.
Oct. 7, 1905.

Sir: I read with interest the letter and your comment on the calking of loose rivets in structural work. It seems that any novice with a modicum of common sense would know that rivets which were loose and made tight by calking would be a serious menace in practically all structures. For example, if there are two loose rivets in a standard connecting angle of but three rivets, the sound rivet would be partially sheared before load would come on the loose rivets.

A point of importance suggested by your criticism is: What inspection can be adopted to discover loose rivets that have been calked in the shop? It would certainly be a laborious job to sound every rivet in a large box column or girder with a four-pound hammer. A well calked rivet could hardly be detected with a lighter hammer.

Certainly all loose rivets should be cut out and replaced by new rivets, and where such work comes from a shop and shows over a certain per cent. of loose rivets it would seem a good idea for the inspector to order the member back to the shop to have new rivets put in by power riveter.

Of course exception must be made when shop is at any great distance.

Several cases occur to me of boilers which had leaking rivets (consequently more or less loose) both in girth seams and heads, and frequently I have seen workmen calk them while the boiler was steaming. In cases like this the rivets should only be calked when boiler is cold and then only for temporary repairs. As in structural work the rivet should be cut out and replaced by a new one.

Very truly yours,
John Van Brunt, M. E.

746 St. Nicholas Ave., New York, N. Y., Oct. 7, 1905.

(The method of heating suggested by Mr. Henning seems effective, but can it be carried out in regular practice? Besides the difficulty of getting the distribution of heat as called for, on the short length of an ordinary rivet, the requirement of a full and well-formed riveted head or set must be given consideration. At any rate this requirement of a full, thoroughly-formed set head is to be found in most specifications for riveting workmanship, though whether rightly or wrongly we cannot undertake to say. The detection of calked or doctored rivets can nearly always be made by eye without microscopic inspection, if the rivet head is clean and unpainted, and we have read or heard somewhere that where a rivet-head shows a coating of tobacco-juice it is to be examined with a suspicious eye and hammer.—Ed.)

Locating a Section Corner from a Random Meridian and Parallel.

Sir: Replying to your correspondent's request, in your issue of Sept. 21, for information regarding a short formula for locating a section corner from the intersection of a random meridian and parallel, I am quite certain that the nature of the problem is such as to render impossible the derivation of a formula that can be called short or simple. It seems to me that the best course in such a problem is to find the simplest process, and for this purpose I am pleased to submit the following solution, which is perfectly general.

Let us first consider the perfectly general case, that is, when the desired point lies anywhere with respect to two axes, as represented in Fig. 1, in this case, in the first quadrant. Let O' represent the desired corner, O the origin of coordinates, and W'OE' the axis of X. From E draw the line EP perpendicular to NS. In the right-triangle POE, OE is known and POE is 180° — SOE. Then

$$PO = OE \cos POE$$

and

$$PE = OE \sin POE.$$

In the right triangle PSE, the side PS = PO + OS; the angle

$$PSE = \tan^{-1} \frac{PE}{PS}$$

and

$$SE = PS \sec PSE.$$

In the triangle O'SE, the two sides O'S and O'E are known, and SE can be found by the formula that has just been given. Then, letting $s = \frac{1}{2}(O'S + O'E + SE)$, we have

$$\cos \tfrac{1}{2} O'SE = \sqrt{\frac{s(s - O'E)}{O'S \times SE}},$$

and

$$OSO' = PSE - O'SE.$$

Then

$$OX = O'S \sin OSO'$$

and

$$OY = O'S \cos OSO' - OS.$$

These formulas are perfectly general; if OX comes out positive, O' is east of the meridian, if negative, O' is west of the meridian; if OY comes out positive, O' is north of O, if negative, O' is south of O. This gives all the information necessary for the location of the section corner.

For example, let us consider the numerical aspect of the particular problem under discussion. Here SOE = 90° 40', OE = 5,311.95 ft., OS = 5,260.9 ft., O'E = 79.70 chains or 5,260.2 ft., and O'S = 80 chains or 5,280 ft.

Then POE = 180° — 90° 49' = 89° — 11'
PO = 5,311.95 × .01425 = 75.71 ft.
PE = 5,311.95 × .99990 = 5,311.41 ft.
PS = 75.71 + 5,260.9 = 5,336.61 ft.

$$\text{Tan } PSE = \frac{5,311.41}{5,336.61} = .99528$$

whence PSE = 44° 51' 52"
and SE = 5,336.61 × 1.4109 = 7,529.32
s = ½ (5,280.0 + 5,260.2 + 7,529.32)
= 9,034.76 ft.

$$\cos \tfrac{1}{2} O'SE = \sqrt{\frac{9,034.76\ (9,034.76 - 5,260.2)}{5,280 \times 7,529.32}} = .92619$$

whence O'SE = 44° 18' 16"
OSO' = 44° 51' 52" — 44° 18' 16" = 0° 33' 36"
Then OX = 5,280 × sin 0° 33' 36" = 51.61 ft.
and OY = 5,280 × cos 0° 33' 36" — 5,260.9
= 18.85 ft.

As OX is positive, O' is east of the random meridian; as OY is positive, O' is north of the random parallel, as represented in Fig. 2, in spite of the fact that your correspondent showed it south on the figure which he submitted to you.

In deriving the formulas given above, the angle SOE was assumed oblique; in case it is acute, angle POE will be equal to angle SOE, and in finding PS, PO must be subtracted from OS, thus,

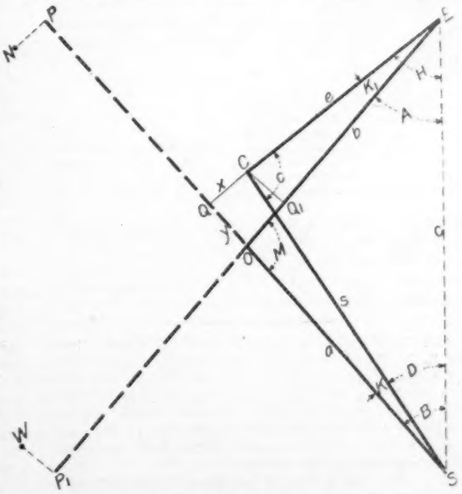
$$PS = OS - PO.$$

The remainder of the work is the same as in the preceding case.

Yours very truly,
Charles E. Smith.

1519 Pine St., Scranton, Pa.

Sir: The problem proposed by your correspondent in your issue of Sept. 21 may be stated in general terms as follows (see accompanying diagram, in which, for the sake of both clearness and generality, the relative positions of the different points have been so chosen as to have distances and angles greatly exaggerated): The recorded distances of the section corner C from the corners E and S, which are the corners next east and south, are, respectively, e and s, as shown. Two random lines SO



and EO were run, one north from S, one west from E. These lines made with each other an angle M, and the distances from their point of intersection O to S and E were, respectively, a and b. It is desired to locate the corner C with reference to the point O and either of the random lines; that is, if the corner is to be located with reference to SO, to find the distances y (= OQ) and x (=QC), the line QC being perpendicular to SO or to SO produced; or, if the corner is to be located with reference to EO, to find y_1 (= OQ_1) and x_1 (= Q_1C).

Your correspondent gives the recorded distances CN and CW, from C to the corners north and west of it,

respectively; also, the perpendiculars NP and WP_1 from those corners to the random lines, and the distances OP and OP_1. These additional data are entirely unnecessary; they make the problem overdeterminate; the measurement of them (except CW and CN) involves a considerable waste of time and labor, and the introduction of them in the statement of the problem is likely to prove misleading and confusing. Furthermore, to measure or express distances to the nearest hundredth of a foot is a useless refinement, not consistent with government work, in which distances are approximated to the nearest link.

The exact solution of this problem is rather laborious, although it involves nothing but elementary trigonometry. It may be briefly outlined thus: In the triangle SOE, in which the sides a and b and their included angle M are given, the angle B and side SE (= c, say) can be readily computed. In the triangle SCE, the three sides are now known, and the angle D can be calculated. Let B — D = K. Then,

$$y = OQ = SQ - SO = s \cos K - a \quad \ldots\ldots\ldots (1)$$

$$x = QC = s \sin K \quad \ldots\ldots\ldots (2)$$

If it is desired to locate C from EO, the angles A, H and K_1 should be calculated, instead of B, D and K. It should be observed that formulas (1) and (2) are perfectly general, provided K is understood to be the algebraic difference B — D; if K is negative, x is negative, or C is west of SO; this is otherwise evident, since in this case D is greater than B, and SC lies on the left of SO. If y is negative, Q is south of O.

The problem can be solved much more readily by the following method, which, although only approximate, gives results that are close enough:

Compute c (it is sufficient to compute log c) by the formula

$$c = (a + b) \sin \tfrac{1}{2} M \quad \ldots\ldots\ldots (3)$$

and angle C by the formula

$$\sin \tfrac{1}{2} C = \frac{c}{s + e} \quad \ldots\ldots\ldots (4)$$

Then, the angles B and D by the formulas

$$\sin B = \frac{b \sin M}{c} \quad \ldots\ldots\ldots (5)$$

$$\sin D = \frac{e \sin C}{c} \quad \ldots\ldots\ldots (6)$$

From B and D the angle K is determined, and y and x are then found by formulas (1) and (2).

Formulas (3) and (4) are obtained thus: In the triangle SOE,

$$c = \frac{(a + b) \sin \tfrac{1}{2} M}{\cos \tfrac{1}{2} (A - B)} \quad \ldots\ldots\ldots (a)$$

As, from the conditions of the problem, SOE is very nearly isosceles, A — B is very small, and $\cos \frac{1}{2} (A - B) = 1$, nearly. Making this substitution in (a), formula (3) is obtained. Similarly, in the triangle SCE we have, approximately,

$$c = (s + e) \sin \tfrac{1}{2} C.$$

whence formula (4) follows. Formulas (5) and (6) are fundamental trigonometric formulas.

In the case given by your correspondent, the data are as follows, distances being in chains:

s = 80.00, e = 79.70, a = 79.71, b = 80.48, M = 90° 49'.

Formula (3) gives

$$c = 160.19 \sin 45° 24' 30''; \log c = 2.057105.$$

Formula (4), expressing angles to the nearest half minute,

$$\sin \tfrac{1}{2} C = \frac{c}{159.70}; \quad C = 91° 9'.$$

Formulas (5) and (6),

$$\sin B = \frac{80.48 \sin 90° 49'}{c}; \quad B = 44° 52' 30''.$$

$$\sin D = \frac{79.70 \sin 91° 9'}{c}; \quad D = 44° 19'.$$

Then, K = B — D = 33' 30", and, by formulas (1) and (2),

y = 80.00 cos 33' 30" — 79.71 = 0.286 ch. = 18.9 ft.

x = 80.00 sin 33' 30" = 0.78 ch. = 51.5 ft.

Yours truly,

Antonio Llano.

Scranton, Pa., Oct. 2, 1905.

Sir: In Engineering News of Sept. 7 I notice a query by R. W. B., of Alexandria, La., as to the proper manner of establishing the center of a section of land where the north and south lines each change their bearing at the quarter corners and have different lengths, should it be by the intersection of two straight lines connecting the opposite quarter corners or should the center be equidistant from the opposite corners.

A circular was issued by the General Land Office, Department of the Interior, on Oct. 16, 1896. This circular quotes the various Acts of Congress governing the public survey, and from them establishes certain General Rules, as follows:

(1) That the boundaries of the public lands established and returned by the duly appointed government surveyors, when approved by the surveyors-general and accepted by the government are unchangeable. . . . . .

(4) That all subdivisional lines of a section running between corners established in the original survey of a township must be straight lines, running from the proper corner in one section line to its opposite corresponding corner in the opposite section line.

Under the provisions of the act of Congress approved Feb. 1, 1805, the course to be pursued in the subdivision of sections into quarter sections is to run straight lines from the established quarter-section corners, United States surveys, to the opposite corresponding corners. The point of intersection of the lines thus run will be the corner common to the several quarter sections, or, in other words, the legal center of the section.

I have found many surveyors who make the mistake of establishing the center of section by measurement, equidistant from the opposite quarter section corners. Where the section is "regular" the result is, of course, the same by both methods, but in cases of irregular sections the error is material. In the case suggested by R. W. B. the section is slightly irregular by having angles at the quarter corners on the east and west. The point 1 (Fig. 1) is the proper position for the center of the section, while the point 2 would be the point established by the method of measuring.

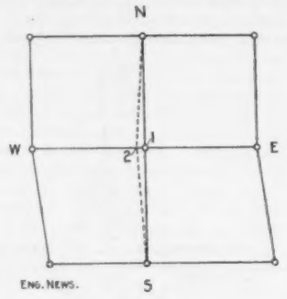


Fig. 1.

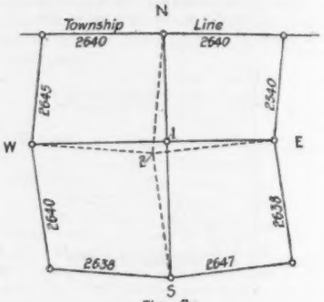


Fig. 2.

There is another case where the error in result by measuring would be still greater. Assume a section bordering on the north township line, say section 5. The closing distance to the township line is 100 ft. short. Accordingly the quarter corner has been established approximately 2,640 ft. from the south and 2,540 ft. from the north line of the section (I have found in my experience where this has occurred where the shortage was over 200 ft.). There are also angles in the east and west lines as well as the south line. In such a case the point 1 (Fig. 2) is where the center of the section should be placed legally. Measurement establishing it equidistant between opposite quarter corners would place it at 2 or between 50 and 60 ft. too far south as well as too far west.

Any surveyor who has had much experience will bear me out in the statement that such "freak" shaped sections are not at all uncommon, and while it would often seem that the establishment by measurement, especially as in Fig. 1 or similar problems, would be the most equitable, giving to each quarter its nearer proper proportion of land, Fig. 2 shows its fallacy and only by following out the strict letter of the law and rulings of the Land Office can uniformity and correctness be secured.

Very respectfully, H. F. Robinson,
Engr. U. S. Indian Service.

Browning, Mont., Sept. 23, 1905.

The Design of Reinforced Concrete Structures.

Sir: Referring to the letter by Mr. C. A. P. Turner in your issue of June 29, 1905, in reference to the reinforced concrete warehouse at Minneapolis, which he designed, and wherein a comparison is made between "assumed or half baked theory and matter of fact as indicated by substantial test," the writers think the system employed is not economical. Strength per se is not sufficient, we must have economy of material and our motto should be: "Maximum strength with minimum material."

Let us consider a simple beam (Fig. 1) supported at both ends:

The equation for the virtual work of this system is

$$\int \frac{M}{EI} \frac{\delta M}{\delta x} dx + \int \frac{N}{EF} \frac{\delta N}{\delta x} dx + \Sigma \frac{S_3 \delta s}{Ef \delta x} = A_1 = \delta. \quad (1)$$

Considering $x = S_2$ as the statical undetermined force we express the other unknown quantities in terms of x, as follows, when M_0 = the bending moment due to loads:

$$M = M_0 - xy$$

$$\frac{\delta M}{\delta x} = -y$$

$$N = -x$$

$$\frac{\delta N}{\delta x} = -1$$

Substituting in (1) we have for the slab,

$$\delta_1 = -\int \frac{M_0 - xy}{EI} y \, dx + \int \frac{N}{EF} (-1) \, dx$$

$$= -\frac{1}{EI} \int M_0 y \, dx + \frac{1}{EI} \int xy^2 \, dx + \int \frac{x}{EF} dx \quad (2)$$

Since x does not vary with dx, it may be considered constant, hence (2) becomes:

$$\delta_1 = -\frac{1}{EI} \int M_0 y \, dx + \frac{x}{EI} \int y^2 \, dx + \frac{x}{EF} \int dx.$$

$$\int y^2 \, dx = 2 \int y \, dx \, \frac{y}{2}$$

This is the statical moment of the area between the steel rods and the center of gravity of the concrete slab

$$\int y^2 \, dx = 2 \left(2 \frac{l_1 h}{2} \frac{h}{3} + \frac{l_2 h}{2} h \right) = h^2 \frac{2 l_1 + 3 l_2}{3}$$

$$\int dx = 2 l_1 + l_2$$

Substituting in (3):

$$\delta_1 = -\frac{1}{EI} \int M_0 y \, dx + \frac{x h^2}{3 EI} (2 l_1 + 3 l_2) + \frac{x}{EF} (2 l_1 + l_2) \quad (4)$$

In this equation

E is the modulus of elasticity of the concrete in compression;

I is the moment of inertia of the concrete slab, and

F is the area of cross-section of the concrete slab.

Further, the virtual work of the other members is:

$$\delta_2 = \Sigma \frac{S_2}{E_1 f} \frac{\delta S}{\delta x} \quad (5)$$

$S_1 = x \sec a$

$S_2 = x$

$S_3 = -x \tan a$

S_3 is the vertical force in the concrete between the slab and the steel.

Differentiating these three equations

$$\frac{\delta s_1}{\delta x} = \sec a$$

$$\frac{\delta s_2}{\delta x} = 1$$

$$\frac{\delta s_3}{\delta x} = -\tan a.$$

Substituting in (5)

$$\delta_2 = 2 \frac{x \sec a}{E_1 f_1} l_1 \sec a \sec a + \frac{x l_2}{E_1 f_2} + 2 \frac{-x \tan a \, h \, (-\tan a)}{E F_1}$$

$$\delta_2 = 2 \frac{x l_1}{E_1 f_1} \sec^2 a + \frac{x l_2}{E_1 f_2} + \frac{2 x l_1}{E F_1} \tan^2 a \quad (6)$$

remembering that $h = l_1 \tan a$

In this equation

E_1 is the modulus of elasticity of the steel.

f_1 and f_2 the area of the steel rods.

$F_1 = \frac{b}{2} (l_2 + 2 l_1)$ = one-half the longitudinal section of the beam.

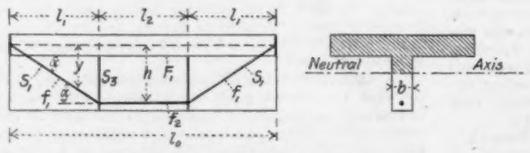


Fig. 1a.

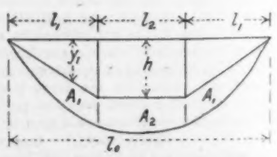


Fig. 2.

Hence the total virtual work becomes

$$\delta = \delta_1 + \delta_2$$

$$= -\frac{1}{EI} \int M_0 y \, dx + \frac{x h^2}{3 EI} (2 l_1 + 3 l_2) + \frac{x}{EF} (2 l_1 + l_2)$$

$$+ \frac{2 x l_1}{EF_1} \tan^2 a + \frac{2 x l_1}{EF_1} \sec^2 a + \frac{x l_2}{E_1 f_2} \quad (7)$$

Equating (7) to zero and solving for x,

$$\frac{1}{EI} \int M_0 y dx$$

$$x = \frac{\frac{l_2}{3EI}(2l_1 + 3l_2) + \frac{2l_1 + l_2}{EF} + \frac{2l_1 \tan^2 a}{EF_1} + \frac{2l_1 \sec^2 a}{E_1 f_1} + \frac{l_2}{E_1 f_2}}{\frac{1}{EI}\int M_o\, ydx}$$

$$= \frac{\frac{h^2}{3EI}(2l_1 + 3l_2)\left[1 + \frac{3I(2l_1 + l_2)}{Fh^2(2l_1 + 3l_2)}\right.}{+ \frac{6\,I\,l_1 \tan^2 a}{F_1 h^2 (2l_1 + 3l_2)} + \left.\frac{3EI(2l_1 \sec^2 a + \frac{1}{2}l_2)}{f_1 h^2 E_1 (2l_1 + 3l_2)}\right]} \quad (8)$$

where we consider $f_1 = f_2$.

The quantity

$$1 + \frac{3I(2l_1 + l_2)}{Fh^2(2l_1 + 3l_2)} + \frac{6\,I\,l_1 \tan^2 a}{F_1 h^2 (2\,l_1 + 3\,l_2)} + \frac{3EI(2\,l_1 \sec^2 a + \frac{1}{2}\,l_2)}{f_1 h^2 E_1 (2\,l_1 + 3\,l_2)}$$

is a constant, depending upon the ratio between the area of the steel and that of the concrete, a proportion which generally is about 1:100. Calling this quantity m, we have

$$x = \frac{3\int M_o\, ydx}{h^2(2\,l_1 + 3\,l_2)m} \quad (9)$$

We will now consider the integral

$$\int M_o\, y\, dx$$

for uniform load (see Fig. 2):

$$M_x = \frac{pl_0}{2}x - \frac{px^2}{2}$$

$$2\int_0^{l_1} My\, dx = 2\int_0^{l_1}\left(\frac{pl_0}{2}x - \frac{px^2}{2}\right)\frac{h}{l_1}x\, dx$$

$$= 2\frac{p}{2}\frac{h}{l_1}\int_0^{l_1}\left(l_0 x - x^2\right)x\, dx$$

$$= \frac{ph}{l_1}\int_0^{l_1}\left(l_0 x^2 - x^3\right)dx = \frac{ph}{l_1}\left(l_0\frac{x^3}{3} - \frac{x^4}{4}\right)$$

$$= \frac{ph}{l_1}\left(l_0\frac{l_1^3}{3} - \frac{l_1^4}{4}\right) = ph\left(\frac{l_0 l_1^2}{3} - \frac{l_1^3}{4}\right)$$

$$= ph\left(\frac{2l_1^3}{3} + \frac{l_2 l_1^2}{3} - \frac{l_1^3}{4}\right) \quad (10)$$

when substituting $l_0 = 2\,l_1 + l_2$.

For the central part

$$\int M_0\, ydx = \int M_0\, hdx = A_2\, h$$

$$A_2 = \left(\frac{pl_0}{2}l_1 - \frac{ph_1^2}{2}\right)l_2 + \frac{2}{3}l_2\left(\frac{pl_0^2}{8} - \frac{pl_0\,l_1}{2} + \frac{pl_1^2}{2}\right)$$

$$= \left(\frac{pl_0\,l_1}{2} - \frac{pl_1^2}{2}\right)l_2 + \frac{\frac{2}{3}pl_0^2 l_2}{8} - \frac{\frac{2}{3}pl_0\,l_1\,l_2}{2} + \frac{\frac{2}{3}pl_1^2 l_2}{2}$$

$$= \frac{pl_0\,l_1\,l_2}{2} - \frac{pl_1^2 l_2}{2} + \frac{pl_0^2 l_2}{12} - \frac{pl_0\,l_1\,l_2}{3} + \frac{pl_1^2 l_2}{3}$$

$$= \frac{1}{6}pl_0\,l_1\,l_2 - \frac{1}{6}pl_1^2 l_2 + \frac{pl_0^2 l_2}{12}$$

Substituting $l_0 = 2\,l_1 + l_2$ and $l_0^2 = 4\,l_1^2 + 4\,l_1\,l_2 + l_2^2$ and reducing, we have

$$A_2\, h = ph\left(\frac{l_1^2 l_2}{2} + \frac{l_1 l_2^2}{2} + \frac{l_2^3}{12}\right)$$

whence

$$\int M_0\, ydx = ph\left(\frac{2}{3}l_1^3 + \frac{l_2 l_1^2}{3} - \frac{l_1^3}{4} + \frac{l_1^2 l_2}{2} - \frac{l_1 l_2^2}{2} + \frac{l_2^3}{12}\right)$$

$$= \frac{ph\left(5\,l_1^3 + 10\,l_2\,l_1^2 + 6\,l_1\,l_2^2 + l_2^3\right)}{12} \quad (11)$$

Hence

$$x = \frac{\frac{3ph}{12}\left(5l_1^3 + 10\,l_2\,l_1^2 + 6\,l_1\,l_2^2 + l_2^3\right)}{h^2\left(2l_1 + 3l_2\right)m}$$

$$= \frac{1}{2}\frac{p\left(5l_1^3 + 10l_2\,l_1^2 + 6l_1\,l_2^2 + l_2^3\right)}{h\left(2l_1 + 3l_2\right)m} \quad (12)$$

If $l_2 = 0$, then $l_1 = \frac{l_0}{2}$ and (12) becomes

$$x = \frac{5}{32}\frac{pl_0^2}{hm} = \frac{1.25}{hm}M_o \quad (13)$$

If $l_1 = l_2 = \frac{l_0}{3}$, substituting in (12) and reducing

$$x = \frac{22}{20}\frac{pl_0^2}{hm_1} = \frac{1.1}{9m_1}\frac{pl_0^2}{h} = \frac{8.8}{9m_1}\frac{1}{h}M_o = \frac{0.977}{hm_1}M_o \quad (14)$$

Now, comparing (13) and (14), since h is constant and since m and m_1 will not have very different values, it is seen that x is greater, when $l_2 = o$ than when $l_1 = l_2$.

From this it is evident that Mr. Turner's construction is not economical; in fact, requires about 25% more steel area than a design in which $l_1 = l_2 = \frac{l_0}{3}$.

Whether the above theory be "assumed or half baked" and whether it be entitled to attention as compared with "substantial" facts, we should be pleased to see discussed.

Respectfully,

F. W. Keyser and
E. Lee Heidenreich.

1741 Railway Exchange, Chicago, Aug. 15, 1905.

Sir: Through your customary courtesy the writer has received proof of the letter of Messrs. Keyser & Heidenreich regarding the relative economy of the construction of a building designed by him.

They present quite an interesting array of mathematics in support of their view which does not seem quite convincing to the writer, aside from the question of its accuracy per se, owing to the fact that no such beam as that discussed was used by the writer in the design in question.

Now the moment of a simple beam such as they discuss is ⅛ Wl at the center, W being the total load and l the span. The bending moment at the supports of a beam under restraint at the columns and continuous over several spans is approximately 1/12 Wl, and the moment at the center is 1/24 Wl. We have twelve continuous spans longitudinally in the building under discussion.

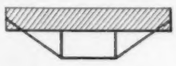
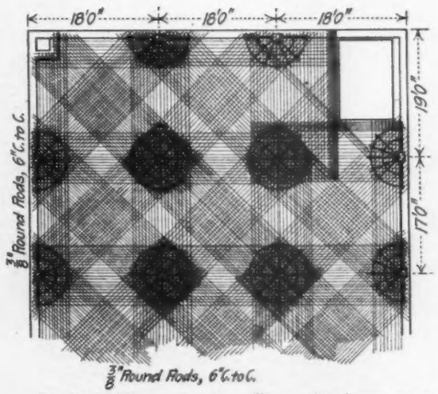
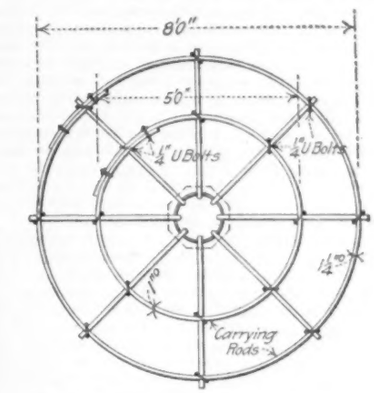


Fig. 1.

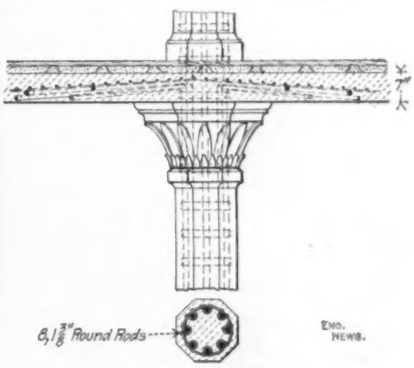
Fig. 2.



Partial Plan showing Floor Reinforcement.



Top View of Column Framing.



Sectional Elevation.

FIG. 3. "MUSHROOM" SYSTEM OF CONCRETE REINFORCEMENT PROPOSED BY C. A. P. TURNER.

Hence, we have in general but ⅔ the maximum bending moment over the support in the continuous beam that we would have in a simple beam at the center such as discussed by them. Further, by lapping the rods over the support we are able to double our section, hence theoretically we get approximately two-thirds the metal required for a simple beam for half the length and one-third the metal for the other half, or about 50% of the metal required for a simple beam owing to the fact that the reinforcing rods are of constant section throughout their length. For the wall spans the economy of continuous construction is evidently not so great. At the point of contraflexure for a uniform load the moment is zero, hence we can incline our rod towards this point without requiring extra section to provide for the moment. We should not, however, bring it to the bottom of the beam at this point if we conservatively provide the condition of partial load.

Now let us take up the question of shear. Aside from the shearing value which the rod adds to the concrete itself by being bedded therein, the amount of shear it can carry due to its inclination will evidently depend upon the strain in the rod and is the vertical component thereof. In the continuous construction we actually have the maximum strain in the rod at the support due to the fact that the beam is continuous and the bending a maximum over the support, hence the strain on the rod is a maximum where most needed to provide this component for shear. In the simple beam we have no strain due to moment at this point and that from shear due only to adhesion of the rod to the concrete.

We will now turn our attention to the discussion and assumptions presented by Messrs. Keyser and Heidenreich. The writer will quote an excellent criticism upon this by an engineer friend, since it is more thorough than the writer would have patience to prepare:

"Keyser and Heidenreich begin by assuming a trussed beam; without any transition they identify the reinforced concrete beam with the trussed beam. That is, they put a sign of equality between the two systems sketched in Figs. 1 and 2 herewith.

"The wide gap of reasoning which this procedure contains; the neglect of all questions as to location of neutral axis; the calm assumption that the reinforcement stress has a constant horizontal component and is transferred wholly at the ends of the rods; their identification of vertical shear in the reinforced beam with truss-block compression in Fig. 1; the neglect of all shear work in the concrete, and their neglect in the "least work" equation, of all work expended on the concrete below their assumed beam of the trussed-beam combination; these and perhaps other features of their procedure would seem to make their results open to serious question at once. You may note, near the beginning of their article, the use of x in two separate significations: First, x = stress in horizontal truss rod, and, second, x = distance of section from end of beam. This double use appears in their statements $M = M_o - xy$, where x is used in its first sense, and the immediately following statement $\frac{\delta M}{\delta x} = -y$, where δx seems to mean the differential of the abscissa. Thus, the two values of x are quietly put equal to each other. Farther on, they write $Mx = \frac{pl_o}{2}x - \frac{px^2}{2}$ as the moment for uniform load, were x evidently means the abscissa along the beam. It would seem to the writer that, without further examination, work involving such procedure must be quite valueless."

The practical motto in executing work should be: "Maximum strength at minimum cost." This is a very different proposition from "Maximum strength with the minimum material." The latter is a mere academic question, the former is of interest to the man who consistently endeavors to meet Wellington's definition of an engineer as a man who will do well for one dollar what any fool can do for two. Such a man will endeavor to solve the problem of economic construction by considering the many variables entering into it; the cost of centering in the various arrangements of beams, and labor of putting it in place, the strength obtainable with varying proportions of mixture and cost of same, the cost and labor of placing the various types of reinforcing; and in the wind-up he will check his solution not by the differential calculus, but by simple addition of the dollars and cents expended to secure known results in point of strength as determined by substantial test unless this has been previously demonstrated by himself or others.

Further, while he will generally assume that he has done no work upon which he could not see some way to improve to a greater or less extent, substantial and convincing proof must be adduced to change his views.

To the critic who has perhaps purchased a three dollar and fifty-cent treatise on reinforced concrete, become so thoroughly impressed with the algebraic discussions therein as to assume that he has a fully developed theory of reinforced concrete, the writer would respectfully recommend for his consideration the words of Chas. F. Marsh in "Reinforced Concrete," Part V, as quoted, following:

"Unfortunately, it cannot be said that we have a thorough knowledge of the various properties of reinforced concrete. . . . It may be that we are wrong from the commencement in attempting to treat it after the manner of structural iron work and that, although the proper allowance for elastic properties of the dual material is an advancement on the empirical formulas at first employed and used by many constructors at the present time, yet we may be entirely wrong in our method of treatment.

"The molecular theory, i. e., the prevention of molecular deformation by supplying resistances of the reverse kind to the stresses on small particles may prove to be the true method of treatment for a composite material such as concrete and metal.

"This theory is the basis of the Cottancin construction, which certainly produces good results and very light structures, and M. Considere's latest researches on hooped concrete are somewhat on these lines."

As the writer has some fifteen or sixteen odd buildings under construction at the present time from his plans of the reinforced concrete, he would not be misunderstood as in any wise holding the view that we cannot design safely at the present time, but rather that there is ample room for all to improve radically on present methods of design and computation which are as Mr. Marsh well puts it, "following after the manner of structural iron work."

Thus far experimental investigation has been confined almost exclusively to simple beams and slabs reinforced in one direction only. Experiments on the crushing of concrete have been confined largely to crushing between forces applied to two opposite faces of the cube and the results that may be obtained by applying equal compressive stress to four sides of a cube are not on record in engineering works. This is the condition of the concrete in the top of a slab reinforced in two directions and the discrepancy between figured results and the far greater loads that may safely be applied to such construction is a fair evidence of the ignorance of the theorist.

That concrete lends itself readily to reinforcement in all directions should lead the practical constructor, as far as may be, to so reinforce his work that the deformation from a strain in one direction may be offset in part by a force in another direction.

Enclosed herewith (Fig. 3) a study along this line, the idea being to avoid the expensive forms for beams to secure a neat and unbroken ceiling line together with a considerable economy of material without sacrifice of strength.

While there would seem no difficulty in figuring this construction along the lines and based on the assumptions generally applied to the slab reinforced in two directions, the actual strength would unquestionably be much in excess of any estimate based on such hypothesis for the reasons above given.

Respectfully yours,

C. A. P. Turner.

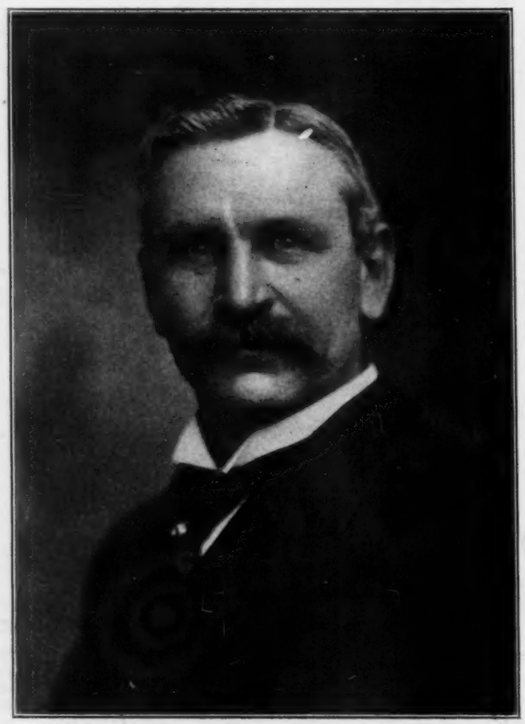
Minneapolis, Minn., Sept. 19, 1905.

PUMPING BY COMPRESSED AIR on the Starrett system, which operates on a principle different from that of the Pohle air-lift, was described at some length in our issue of Nov. 24, 1904, and a pump on this system is now in use for pumping water from a deep well to a lake at the Cypress Lawn cemetery, San Francisco, Cal. It is of the single cylinder type, with a vertical cylinder or chamber 10 ins. diameter and 4 ft. high. The well is 280 ft. deep, and the lift from the surface of the water in the well to that in the lake is 95 ft., having been lowered from 60 ft. There are also three Pohle air-lifts, but it is stated that if the water level is lowered much more they will not be able to work, for lack of sufficient submergence of its pipes. The Starrett pump, however, will then be at an advantage, and can carry a low pressure of air for the increased lift. The same system is to be adopted for some new wells at the same place, the pumps being put down at a point where the cylinders will fill readily, and an air pressure of 30 to 40 lbs. will be used, instead of the 90 lbs. now required for the Pohle pumps, thus effecting a saving in the work of compression. The Starrett pumps are built by the W. G. Leale Co., of San Francisco.

GEORGE WILLIAM CATT.

Mr. George W. Catt, M. Am. Soc. C. E., President of the Atlantic, Gulf & Pacific Co., died on Oct. 8 at his home in New York City from a complication of intestinal diseases following a surgical operation.

On Monday, Sept. 11, Mr. Catt was seized in his office with gall stone spasms, and was operated upon shortly afterward for this trouble. To the dismay of the surgeons, it was found that the gall stones were a minor trouble, and that an intestinal ulcer which had already reached perforation was the grave danger. The operation, while successful for the end anticipated, could not remedy the graver trouble, and the digestive functions were never resumed. Death ensued from lack of nourishment on the evening of Oct. 8.



Geo. W. Catt

Mr. Catt was born in Davenport, Ia., March 9, 1860. He received his preliminary education in the public schools, and entered the Iowa State College, through which he paid his way, largely by his own efforts. He graduated in the class of 1882, receiving the degree of Civil Engineer.

During his engineering course he found time to give a year to the study of Commercial and Contract Law, and to this training he later ascribed no small part of his success as a director of great enterprises.

After graduation, Mr. Catt joined the forces of the King Bridge Co., of Cleveland, O., at its Des Moines, Ia., office, and he represented it as bridge and contracting engineer in the Mississippi Valley for several years. In 1885 he was commissioned by that company to conduct its business on the Pacific Coast.

As a bridge contractor he was so brilliantly successful that the leading bridge building firm of the extreme West—the San Francisco Bridge Co.—engaged his services as Chief Engineer in 1886. In this new position he built several large structures on the Pacific Coast, notably a combination three-hinged arch of 340-ft. span across the Fraser River at Lillooet, B. C. From that time to his death, he was associated with this and other firms identified with large engineering enterprises on the Pacific Coast.

In 1889 the San Francisco Bridge Co. opened an office in Seattle, Wash., placing Mr. Catt in charge. Within six months the great fire occurred which destroyed the improved water front of Seattle and gave him an opportunity to play the largest part in the reconstruction of the wharves and other water front structures thus destroyed.

In 1890-1 the Great Northern and other railroads became active in completing their lines in the Northwest, and much of the bridge and trestle work on the lines in the State of Washington was built under Mr. Catt's direction. During this busy period of his career, he constructed in one year, fourteen miles of railroad trestle, one-half mile of railroad truss bridges, and about one quarter of a mile of highway bridges.

About 90 miles of the Great Northern R. R. along the Coeur d' Alene River were undertaken by him about this time, and on this work he introduced the novelty of electric rock drills handled from a floating power plant moored to the river bank.

In 1891, during an Eastern vacation trip, Mr. Catt went to Boston and bid for a hydraulic dredging contract in Boston Harbor—somewhat unexpectedly obtaining it. This led to the construction in 100 days of a large hydraulic dredging plant and the successful inception of the very extensive Atlantic Coast business, of which he was the controlling spirit at his death. The nexe year he built a second hydraulic dredge at Jacksonville, Fla., for use on Government contracts.

In 1892 the Atlantic Coast business was reorganized and reincorporated under the name of the New York Dredging Co., with Mr. Catt as President, and under this organization he performed many million cubic yards of hydraulic dredging for the Government and private parties, constructed a third large hydraulic dredging plant for his own company, and a fourth—the "Delta"—a 34-in. dredge for the Mississippi Commission, on novel and successful lines. He also constructed the first modern drainage station for the City of New Orleans, using two huge 54-in. centrifugal pumps directly operated by the triple expansion engine.

One of the most interesting engineering works of Mr. Catt's career was the construction of the ship canal, seven miles in length, from Sabine Pass, Tex., to Port Arthur, to form a private harbor and approach thereto for the Kansas City, Pittsburg & Gulf R. R. (since reorganized as the Kansas City Southern Ry.). During this work a 20-in. dredge of Mr. Catt's design, with a main engine of only 230 H. P., dredged and put ashore, behind levees, 296,000 cu. yds. of solid material in 24 consecutive working days, a record which has never been equalled, considering the power available.

In 1899, the New York Dredging Co. disposed of its business to a new and larger corporation, the present Atlantic, Gulf & Pacific Co., which now conducts an extensive business on the Atlantic Coast, the Gulf Coast and the Pacific Coast of the United States and in the Philippine Islands. Mr. Catt was the company's President and Chief Engineer, and at the time of his death he was also Consulting Engineer and Vice-President of the Puget Sound Bridge & Dredging Co., of Seattle; and Consulting Engineer of the San Francisco Bridge Co. and of the British Columbia General Contract Co.

Mr Catt built a fifth hydraulic dredge at Washington, D. C., in 1898, and was constantly engaged in general bridge and other work through the various offices of his company.

In 1901, the Atlantic, Gulf & Pacific Co. was successful in obtaining the great contract for the improvement of Manila Harbor, and in this work, now just completed, Mr. Catt reached the pinnacle of his successful engineering and business career. This involved the rebuilding and extension of the Spanish jetties, the dredging of a huge anchorage basin in the front of the City of Manila to the depth of 30 ft., the construction of an ad-

ditional breakwater for the protection of this basin, and the building of a rock bulkhead in front of the city, behind which the spoil of the hydraulic dredging was deposited, making a new city front abutting on deep water, and involving a total expenditure on the part of the Insular Government of $4,000,000.

A 24-in. steel hull hydraulic dredge was designed by Mr. Catt for this work, and with this machine he again recorded an unsurpassed achievement by dredging and putting ashore through a long pipe line, in one day of 24 hours, a maximum of 29,000 cu. yds. of solid material, or a total for a month of 400,000 cu. yds., notwithstanding interruptions by the weather and stoppages for repairs.

In addition to this, a very large quarry outfit, with a fleet of rock barges, tug boats, floating derricks, etc., were established, and the entire work was carried out most successfully.

While this work was in progress, Mr. Catt also took the contract for his company to construct the coaling station at Sangley Point near Manila, involving a total expenditure of $553,000, and the design and construction of coaling sheds, steel wharf, open bunkers and hoisting towers, requiring 3,000 tons of structural steel and 7,000 cu. yds. of foundation concrete.

Before this great work at Manila was completed, Mr. Catt took a very large contract from the Cape May Real Estate Co. for the reclamation of the salt marshes contiguous to Cape May, N. J., for the extension of that town and its boulevards, involving the dredging and the depositing of 10,000,000 cu. yds. of material. Mr. Catt took over in part compensation for this service one very large and one small hydraulic dredge which had been operated by the Cape May Real Estate Co.; and one of the most successful of his engineering feats was the rebuilding of these unsuccessful dredges to a condition of efficiency and profit.

Mr. Catt was elected to membership in the American Society of Civil Engineers in 1892 and in the American Society of Mechanical Engineers in 1904. He was also a member of the Institution of Civil Engineers of Great Britain, of the Engineers' Club of New York City, of the Franklin Institute of Philadelphia, of the American Academy of Political and Social Science and of the American Economic Association.

In 1892 he became one of the founders of the Northwest Society of Engineers at Seattle, and was its first President. In 1903 he was elected President of the Alumni Association of the Iowa State College, and held this position at the time of his death.

He won his place in professional circles, and his great business and financial success by virtue of his rare abilities and high personal character, which brought also around him a wide circle of friends.

In 1890, Mr. Catt married Mrs. Carrie Lane Chapman, of Iowa, formerly a college acquaintance, and he leaves no children. During his successful business career, Mrs. Catt as President of the Woman Suffrage Association of the United States and afterwards as President of the International Woman Suffrage Association achieved wide distinction for herself.

Typical of them both is the provision of his will that his body shall be left, in the interests of science, to the surgeons of the hospital, so that even after his death he may contribute to the advancement of scientific knowledge.

Mr. John McMullen, of San Francisco, who first of his business associates, discovered in Mr. Catt his magnificent promise and who for nearly a quarter of a century was most intimately associated with him, says:

"He was gentle, kind and true, magnanimous and generous to a fault. His integrity was absolute. His whole life in all its relations was faithful, high and noble. His frank and considerate manner won the esteem and love of every one who came in contact with him. His good fellowship never faltered. He was a man of exceptional parts and unwavering in devotion to duty. We shall not look soon upon his like again."

TENSILE STRENGTHS OF STONE IN LARGE AND SMALL SPECIMENS.

Comparative tests were made recently at Vienna, Austria, by Prof. A. Hanisch and O. Mayer, to determine the relation of the tensile strength shown by a briquette test to the true tensile strength as shown by a larger prismatic test piece. The tests were made on various specimens of natural stone: sandstones, limestones and granite. They exhibit clearly the fact that, *in general*, the briquette-strength is greater than the large-size tensile strength; as a maximum, with certain stones, it may be twice as great.

The large-size tests were made on specimens 1½ m. (4.92 ft.) long, with a prismatic cross section having an area of 150 to 225 sq. cm. (23.5 to 35.5 sq. ins.), and enlarged at the ends for attaching the grips. The central prismatic portion of these pieces had a length of 21 to 24 ins., and was well filleted at the junction with the enlarged ends. Stress was applied to the specimens by means of a 3-in. bolt passing through a transverse hole in each of the enlarged ends. Proper provision was made to secure central stressing, by cast cement bushings in these holes with only a narrow central bearing of the bolt in the cement. The bolts were connected to the heads of the testing machine by a universal joint, for the same purpose.

The briquettes tested for comparison with the large specimens were of standard size and shape, that is with a central cross-section of 5 sq. cm. (0.79 sq. in.) and enlarged ends held in embracing clips.

The direction of stress in the various specimens was in the direction of the bedding planes. The small test-pieces were in all cases cut from the halves of the large specimens after fracture, three small specimens being cut from each large specimen to give a fair average. Eight varieties of stone were tested, from one to three large-size specimens of each being pulled. It is noted that nearly all the fractures of the large specimens were fairly plane and normal to the longitudinal axis, and lay in the middle third of the length. The individual results, moreover, were quite uniform for a given kind of stone, as may be seen from the tabulated results in the table below.

The last column of the table gives the approximate ratios of large-size strength to briquette-strength. As will be seen, these ratios range from 0.5 to 1.0, but never exceed unity. The latter figure holds for granites, while limestones have the lowest ratios. As a further indication of the properties of the several kinds of stone, their crushing strengths are given in the first column. These appear to bear no definite relation to the ratios in the last column.

The authors suggest, in the article from which the preceding is taken ("Baumaterialienkunde," Aug. 1, 1905, pp. 200-211) that similar results may reasonably be expected with cement and related materials. The results are, broadly, comparable to results obtained in tension tests of notched metal bars, which give apparent higher strengths than tests on prismatic sections or on large-size specimens.

Comparative Tensile Strengths of Stone in Large Specimens and Standard Briquette-Shaped Specimens.

Kind of Stone.	Crushing Strength, lbs. per sq. in.	Tensile Strength, lbs. per sq. in. —A. Large Specimens.— Single Tests.	Means.	—B. Small Specimens.— Single Sets.	Means.	Ratios A ÷ B.
Calcareous sandstone	1,400	90.5 90 75	85	200 167 104	157	0.5
Dense limestone	14,000	398	398	697	697	0.6
Calcareous sandstone	2,520	138 184	136	198 193	196	0.7
Sandstone	18,200	292 182 271	248	339 261 299	300	0.8
Marble	12,600	1,150 1,085 1,310	1,182	1,435 1,280 1,420	1,362	0.9
Granite I	23,800	1,010 833 942	928	830 803 903	845	1
Granite II	24,500	774 1,095 592	820	914 820 802	845	1
Granite III	22,400	658 492 520	557	579 456 631	555	1

A RAILWAY TUNNEL under the Detroit River at Detroit, Mich., is a probability of the near future. Plans have been practically completed by the Michigan Central R. R. to begin in a few months the construction of a twin tube tunnel connecting its Canadian and Michigan lines. The work will be carried out by a separate organization known as the Detroit River Tunnel Co., of which Mr. Wilson S. Kinnear, Assistant General Manager and formerly Chief Engineer of the Michigan Central R. R., is chief engineer. As planned, the tunnel will be 7,200 ft. long between portals, of which length 2,500 ft. will be under the river channel. The details of the structure have not yet been made public.

DESIGNS FOR HARBOR IMPROVEMENTS at Goteborg, Sweden, were called for several months ago and about 40 competitive designs were received. The three prizes were awarded as follows: 1st ($1,500), the Aktiebolaget Vattenbyggnadsbyran, of Stockholm; this proposes a great widening of the river, and an island with long piers and slips, together with warehouses, railway freight yards, etc. 2d ($1,000), Unander & Jonsson, engineers, of Stockholm, and N. Victorin, C. E., of Gefle, Sweden; this proposes a quay or dock wall along one part of the river bank and at another point a series of slips and piers diagonal to the river. 3d ($375), G. Lorenz and G. Schonweller, engineers, of Copenhagen, Denmark; this proposes two very long piers in the river (parallel with the banks), each connected with the shore by an extension at one end, and having warehouses and other facilities. The committee of award was composed of G. J. de Jongh, P. Laurell, H. C. V. Moller, J. A. Waller and Philip Aquist. We are informed that none of the plans have been adopted to be carried into execution.

A STREET RAILWAY ORDINANCE of considerable interest has been submitted to the Chicago council committee on local transportation by the Chicago City Ry., presenting its proposed solution of the present traction controversy. The ordinance provides for a 20-year extension of franchises for streets already occupied, in return for which the company would waive all present right in the way of unexpired franchises. The city is given the right at any time to purchase the properties of the company, the purchase price to be the appraised value of the company's tangible property and the value at the time the appraisement is made of whatever franchise rights the company now has. The company agrees to pay 3% of its gross receipts for the first five years, 5% for the next two years, 7% for the next ten years, and 10% for the remainder of the grant. This compensation, however, shall be in lieu of any car license tax and from it shall be subtracted whatever the company has to pay as a tax on its capital stock. The tax on its tangible property shall not be subtracted. The company agrees to rehabilitate within three years its entire system, using the best type of cars and providing enough of them to accommodate its patrons. It agrees to lay grooved rails in all paved streets and to pave its right of way, clean and sprinkle it, and remove the snow. Also to repave when this is done to the remainder of the street.

The right to charge a 5 ct. fare is asked for and the company agrees to give and accept transfers to and from the Union Traction Co. at all junction points south of 12th St. To obviate the transferring of passengers in the downtown district it agrees to run through cars between the south, west, and north sides to which passengers from points outside of the zone in which they run will be transferred for the single fare and from which transfers will be given to cars running outside their zone. A trial of the underground trolley in State St. is provided for with an agreement that if it is a success there it shall be used throughout the downtown district.

At the termination of the franchise the city will have the option of either purchasing the lines itself, paying only for the tangible property, authorizing another company to purchase it or giving the existing company a new ordinance. In the former event only the tangible property of the company shall be considered in estimating its value and not the amount of its capital stock, bonds, or any other form of capitalization. In conclusion the ordinance provides for a referendum before its final adoption.

The Chicago Union Traction Co. will submit an ordinance very similar to the above but including provision for the lowering of its tunnels under the Chicago River.

THE MERMENTAU DAM was blown up by dynamite on Oct. 3, placed and exploded, it is supposed, by the neighboring farmers and stock raisers who have vigorously objected to the structure ever since it was put into operation. The dam was described in our issue of Sept. 28, 1905, and was built to shut off the access of salt water to the irrigating works of the large rice plantations which abound in this section. The local farmers not engaged in rice growing complained that the dam caused the flood-

ing of their land and appealed to the courts for redress. Apparently procedure by law was too slow and dynamite was used to settle the dispute.

TWO NEW STEAMERS are being built for the transatlantic service of the Canadian Pacific Ry. by the Fairfield Co., of England, and the first of these will be launched in a few weeks. They will be named the "Empress of Britain" and "Empress of Ireland," and will run between Montreal and Liverpool, but are built with a view to a possible transfer to the company's Pacific fleet. They are 550 ft. long, 64 ft. beam, and of 14,500 tons, with twin-screw balanced engines designed to give them a sea speed of 19 knots. The mail contract is now held by the Allan Line, as its two new turbine steamers, the "Victorian" and "Virginian," are faster than any of the present vessels of the Canadian Pacific Ry. line, and the competition has led the latter company to improve its service.

AN IMPORTANT RAILWAY DEAL, formally completed on Oct. 10, is the absorption of the Cincinnati, Hamilton & Dayton-Pere Marquette system by the Erie Ry. The absorption was accomplished by direct purchase on the part of the Erie of a controlling stock interest in the C., H. & D., which latter railway has for some time held a 999-year lease of the Pere Marquette Ry. The Erie Ry. thus acquires an extensive system of line in the Central States, including Michigan and effectively reaching Wisconsin by a system of car-ferries across Lake Michigan. The system acquired by the Erie, it is said, will not be kept distinct, but will be thoroughly Erie-ized. There is talk, since the deal was announced, of a possible new through transcontinental railway service over the Erie, the Wisconsin Central (Chicago-St. Paul) and the Great Northern railways.

A WATER HAMMER DRILL, utilizing the principle of the hydraulic ram, was exhibited by an inventor named Wolski at the recent Liege Exhibition. The water supply to the drill mechanism passes through a pipe equipped with an air chamber and exhausts through a valve placed in a right-angled connection of larger size than the vertical supply pipe. When a certain velocity is reached the pressure of the exhaust water on the valve plate closes the valve, which works against a spring. This causes a water hammer, which acts on a piston placed directly below the vertical supply pipe, thus driving a drill. The apparatus may be adjusted to various rates of drill speed. A number of modifications of the device, to meet differing conditions, have been made. It appears that as early as 1867 a British patent for a similar utilization of hydraulic power was issued to one Balzberg, but that the device then patented was never put to practical use. A two-page illustrated description of the "Wolski hydraulic ram boring apparatus" has just appeared in London "Water" for Sept. 15, 1905, having been taken, in turn, from the "Petroleum Review," presumably also a British publication.

SUCCESSFUL USE OF A DIVINING ROD is reported by Mr. G. Franzius, of the German Harbor-Construction bureau, associate director of the construction of the Kiel concrete dry-docks, in the "Zentralblatt der Bauverwaltung" of Sept. 13, 1905. The occasion for a trial of divining-rod performance presented itself a few months ago when it became necessary to sink additional wells on the grounds of the Imperial Navy Yard at Kiel for water supply. In this territory water is found overlying an impervious hardpan whose upper surface is very irregular. The conditions are such that at one point a bore-hole may give ample water, while a dozen feet away no water is struck, and at still other points artesian flows of low head may be obtained. In order to avoid, if possible, the expense of many trial bore-holes, Mr. Franzius obtained the assistance of one Mr. von Bülow-Bothkamp, who had made a large local reputation as a water and gold finder. The appliance used by him is a piece of iron wire, about ⅛-in. or less in thickness, bent to the form of a loop with long crossed ends; this "rod" is held by grasping in the two hands its opposite ends, which thus serve as axis, and allowing the loop portion to project horizontally forward from the body. When passing over or near an underground flow of water (apparently Mr. v. B.-B. is able to indicate only flowing underground water), the loop of the "rod" flies up sharply, striking the operator's breast. Armed with this instrument, the expert first discovered a large underground flow, undiscernible from the surface, but well known to the engineer in location and direction because it had been tapped during the dry-dock work; the expert at once found its course and its direction. Next, at a driven well which had been closed off with a plug some time before, the expert obtained no reaction, in spite of the positive statement of the engineer's assistant that this pipe had given an artesian flow. As proof of the expert's error, the plug was taken out of the pipe, when, lo! no water came. It is thought possible that a well driven some 60 or 70 ft. away may have laid dry the flow supplying the first well. The next test, made at the second well, an artesian bore-hole, was for depth of supply flow; the expert guessed 43 ft., which was correct. He next discovered a large flow, suitable for an additional well, and, as the first discovered location was inconvenient, he followed its course some 100 yds. to a point where he said water would be struck at 50 ft. depth. Subsequently an excellent well was put down here, with a natural head of several feet above the ground surface. By this time the expert was visibly exhausted, so that work was stopped. At the discovery of the spring last noted, he asked Mr. Franzius and others of the party to touch the "rod" which he held; the former and some of the others claim to have felt distinctly something like an electric shock, while others were insensitive. Mr. Franzius later was able himself to obtain reactions with gold and water, using a bent fresh walnut twig, and also found some among his acquaintances who could, in varying degrees of strength, detect the effects in question. Judging by his signed article above referred to, from which the preceding is taken, Mr. Franzius appears firmly convinced that there is something in the matter.

A METROPOLITAN PARK SYSTEM for Chicago is proposed, the plan being to purchase land along the lake shore, the north branch of the Chicago River, the Desplaines River and the Calumet River. These outlying natural parks would be connected up by parkways and driveways, and also connected with the present park and boulevard system. The project also includes a number of small parks and playgrounds. The lands in question include about 37,000 acres of open prairie and forest land, and can for the most part be purchased now at the prices for farm land, but as the city extends they will gradually be purchased and developed by real estate interests and the prices will rise correspondingly. The matter is to be voted upon by the public on Nov. 7, and the Outer Belt Park Commission which was appointed to lay out the proposed system is holding public meetings to explain the matter and try to arouse popular endorsement of the project. At one of these meetings Mr. Henry G. Foreman, President of the Commission, stated that in the relation of park area to population Chicago now stands nineteenth in a list of American cities. According to a paper on "The Chicago Parks" read by Mr. A. C. Schrader, Chief Engineer of the West Park Commission, at the annual meeting of the Illinois Society of Engineers and Surveyors, the present condition is as follows: Area of city, 122,008 acres; area of parks, 3,180 acres; population, 1,962,250; population per acre, 16.08; population per acre of park, 617.10; park area per capita, 70.58 sq. ft. The subject was also presented at a meeting of the Western Society of Engineers on Oct. 4 by Mr. Dwight H. Perkins, architect to the Board of Education, who has taken considerable interest in improvements of this kind. In actual area of parks, Chicago now stands seventh among the leading American cities: Boston (with its outlying park system) heads the list with 12,878 acres; New York comes next with 8,074 acres, and the others range between 3,737 for Los Angeles and 2,911 for Washington, D. C.

PERSONALS.

Mr. W. P. Cain has resigned his position as City Engineer of Leadville, Colo.

Mr. Samuel D. Brady, Chief Engineer of the Little Kanawha R. R., has been also appointed Chief Engineer of the Marietta, Columbus & Cleveland R. R.

Mr. H. M. Morse, Engineering Aid with Mr. C. C. Babb, of the U. S. Reclamation Service, in Montana, has been transferred to the Washington Office.

Mr. S. M. White has been appointed City Engineer of Superior, Wis., succeeding Mr. Howard Thomas, who has resigned to devote his entire time to private practice.

Mr. Thos. Grieve, of Colorado, has been appointed Hydrographic aid in the U. S. Geological Survey and has been directed to report to the Washington Office.

Mr. John G. Sullivan, M. Am. Soc. C. E., formerly a District Engineer on the Canadian Pacific R. R., has been appointed Assistant Chief Engineer for the Isthmian Canal.

First Lieuts. Wm. A. Mitchell, Robert R. Ralston and W. T. Hannum, Corps of Engineers, U. S. Army, have returned from the Philippines, and will be assigned to Washington Barracks.

Mr. M. O. Spicknall has resigned his position as Chief Draftsman for the Cincinnati Traction Co., of Cincinnati, O., to accept a similar position with J. G. White & Co., Ltd., of London, England.

Mr. K. B. Thornton, Operating Manager of J. G. White & Co., has been appointed Manager of the Nassau Light & Power Co., at Roslyn, Long Island. This company is managed and operated by J. G. White & Co.

Mr. Francis Marion Ferguson, President of the Ferguson Contracting Co., of New York and Pittsburg, was married to Miss Bertha Henshaw Sweeney, of Chicago, at the Hotel Lincoln, Pittsburg, Pa., on Oct. 1.

Mr. Joseph Cawley, formerly of James Bonar & Co., Inc., and the Pittsburg Feed Water Heater Co., Frick Building, Pittsburg, has assumed the position of vice-President of the Cadwallader Tin Plate & Metal Co., of Pittsburg, Pa.

Mr. Henry J. Saunders, for the past year and a half Assistant Engineer of the U. S. Reclamation Service on the Shoshone Project, Cody, Wyo., has resigned to accept a responsible position in the Chief Engineer's Office of the Union Pacific R. R., at Omaha, Neb.

Mr. Albert T. Stiles, of Minnesota, who has been an Engineering Aid in the U. S. Reclamation Service since May, 1904, and who was furloughed to permit an assignment to hydrographic work under the Peruvian Government, has decided to remain in his present employment and has resigned his position with the U. S. Government.

Mr. John C. Ostrup, M. Am. Soc. C. E., formerly Designing Engineer of the Boston Elevated R. R., and afterwards Consulting Engineer in Boston and New York, and who was recently appointed vice-President and Chief Engineer of the American Engineering Co., Indianapolis, Ind., has now arrived in that city and assumed his new duties.

First Lieut. Douglass MacArthur, Corps of Engineers, U. S. Army, has been ordered to Tokyo, Japan, where he will become aid-de-camp on the staff of his father, Maj.-Gen. MacArthur, who has been observing the operations of the army of Japan, and is now about to return to the United States. He will inspect the British troops in India on his way back.

Mr. H. Deane, M. Inst. C. E., for the past 16 years Engineer-in-Chief of the Railway and Tramway Construction Branch of the Department of Public Works of New South Wales, has severed his connection with that department and has opened an office in the Hoskins' Building, Spring St., Sydney, N. S. W., for his practice as a consulting engineer.

Mr. M. J. Caples, General Manager of the South & Western Ry., the Lick Creek & Lake Erie R. R., and the Carolina Co., will also assume the duties of Chief Engineer of the above companies, vice Mr. Geo. A. Kent, appointed Chief Engineer of the Coal Land Department. Other appointments on the engineering staff of the South & Western Ry. have been made as follows: Mr. Wm. A. Hankins, Principal Locating Engineer; Mr. Walter A. Doane, Principal Assistant Engineer; Mr. C. H. Crosby, Division Engineer; Mr. A. W. Jones, Division Engineer.

Obituary.

Boynton Leach, formerly a Lieutenant in the Navy, but for some years employed as a draftsman in the Navy Department, died Oct. 5 in Washington, D. C.

John Veith, for 25 years General Mining Superintendent of the Philadelphia and Reading Coal & Iron Co., died suddenly Oct. 8 at Pottsville, Pa., from paralysis. He was 70 years old.

George W. Catt, M. Am. Soc. C. E., President and Chief Engineer of the Atlantic, Gulf & Pacific Co., died Oct. 8 at his home in New York City. A fuller obituary of Mr. Catt is given elsewhere in this issue.

Henry J. Hopper, ex-Mayor of Jersey City, N. J., died Oct. 5 at his home in East Orange, N. J. He had been engaged in steel construction work for the greater part of his business career. At the time of his death he was connected with the Crucible Steel Co., of New York.

Frank L. Fales, Assoc. M. Am. Soc. C. E., died Oct. 5 in Denver, Colo., where he had gone for his health. Mr. Fales was graduated from Harvard University in 1888. He then studied civil and sanitary engineering in Switzerland for one year, returning to America to complete his scientific education at the Lawrence Scientific School. As a civil and sanitary engineer he had been employed by the Municipalities of Lawrence and Cambridge and by one of the Massachusetts State Metropolitan Commissions. His last position, previous to going to Denver last spring, was that of Assistant in the Office of the Chief Engineer of the Commissioners of Water-Works of Cincinnati, O. He was born in Milford, Mass., in 1865.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., S. F. Patterson, Concord, N. H.

LAKE SUPERIOR MINING INSTITUTE.
Oct. 17, 18. Annual meeting on the Menominee Range, with excursion. Secy., A. J. Yungbluth, Ishpeming, Mich.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting at New York, N. Y. Secy., F. R. Hutton, 12 West 31st St., New York.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on Oct. 4, Mr. Dwight H. Perkins read a paper on "A Metropolitan Park System for Chicago." He described the proposed system of outlying parks in the valleys of the Desplaines, Chicago and Calumet rivers, and the small parks and public playgrounds to improve conditions in the poorer and densely populated sections of the city. Addresses on the same subject were made by Mr. H. G. Foreman, Chairman of the special park committee; Mr. J. F. Foster, Superintendent of the South Park Commission, and Mr. R. H. Warder, Superintendent of Lincoln Park.

ENGINEERING LITERATURE

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A valuable review of literature on hydrology is given in Prof. D. W. Mead's notice of "The Hydrology of the State of New York," elsewhere in this Supplement. It is only fair to our readers and to Professor Mead to say for the latter that he has modestly omitted all reference to his own helpful and suggestive "Notes on Hydrology," reviewed in our issue of Dec. 15, 1904. Of Mr. Rafter's contribution to hydrological literature we need say nothing except to endorse Professor Mead's words of commendation and to approve the policy of the New York State Education Department in making so valuable a report available to the public at so reasonable a price.

On another page we note the issue of a pamphlet containing the Standard Methods for Testing and the Standard Specifications for Cement adopted by the American Society for Testing Materials. That society has now formulated and adopted a dozen or more sets of standards, whose number is rapidly being increased and which are or may be subject to frequent revision. In view of the large number of engineers vitally interested in specifications and standards it would be a most convenient and desirable thing to have all the adopted standards of the society, whether of specification, test procedure, or classification, brought together in a single volume. Why can not the Society make the preparation of such a codified standard volume one of its duties? The sales should be sufficient to cover the cost of annual or biennial issue. The individual specifications being set and printed anyway, for sale in separate pamphlet form, their combination in a single volume would entail a relatively small additional expense. The extra editorial work involved would also be small, consisting chiefly in the preparation of prefatory notes on the origin and date of the several specifications and standards.

The Scope of Reports of Public Engineering Departments.

In the immense volume of technical or semi-technical literature which appears in the form of reports of public officials and departments there is naturally a great variation of quality. The style ranges from excellent to execrable, and the amount of subject-matter varies equally widely from the too much to the too little. These diverse characteristics, as they appear more strikingly in this or that group of reports, frequently give rise to general reflections on the proper scope and qualities of the report of a public engineering department. Be it remembered that such reports are, in the aggregate, an important and valuable part of engineering literature, since they form records—in most cases the only records—of municipal, state or national work in both design and construction. It may be profitable, therefore, to set down in this place some such reflections, written more or less at random, in the expectation that they may contain a stimulus to individual consideration of the subject.

As concerns the style exemplified in such reports, it is at once conceded that criticism or comment is inappropriate to our present purpose. For, style is the man, and is not subject to general instructions nor likely to be improved through the influence of general criticism. In the matter of proper scope, or choice of matter, however, discussion promises more fruitful results. The usual complement of ideas on this subject is, it would appear from the average of the published reports of engineering departments and bureaus, quite limited and diverse, so that the need for improvement may be assumed as a premise. Further, the subject is one which, in part at least, can be brought under some general principles, modified as they may be by individual special factors. This subject of Scope, then, will be the theme of the present remarks.

Primarily, both subject-matter and treatment of the annual and special reports issued by an engineering bureau depend on the limitations of the scope of that bureau's official work. An annual report has the purpose of giving a concise summarized statement, upon official authority, of the work done by the bureau during the year. The descriptive account may be interspersed with some whys and wherefores at this point or the other, to indicate the course of the mental labors embodied in the executed work, and it may, where necessary, contain brief statements of review and forecast for past and future work, and also references (of catalogue character) to the incidental, non-official work of the bureau, such work as is done in connection with the by-products of the exercise of its specific functions. Special reports, as distinguished from the routine annual or periodical reports, are less definite in their characteristics, depending largely on the occasion or emergency which calls them forth. A technical bureau, subject to an administrative superior official, may have various occasion to render written report: first, at certain administrative periods, as yearly; second, upon completion of a single large undertaking which is not completely covered in any one annual report and whose records it may be desirable to bring together in one place; third, at any time upon request of the superior, to enable him to guide his action in a special question, or for publication in the common interest of the bureau and the public. All these classes of reports are essentially objective, it is evident, except as the third class may include matters of explanation or justification of particular actions of the bureau or its individual employees. Thus, in both annual and special reports, it is the specific work of the bureau that is determinative for scope and kind of treatment.

The preceding is, of course, statement rather than argument or proof, and intentionally so. Profitable discussion of a subject of the kind here considered depends more upon taking a clear, consistent view of the conditions than upon finesse of the logic subsequent to a statement of the conditions; we aim to present, therefore, merely an individual view which it has been aimed to make consistent and simple.

We have in the preceding spoken of the specific functions of a bureau, and of by-products of the exercise of those functions. These terms require, for clearness, some explanation. It will be generally conceded, we take it, that every public bureau is created and continued for the exercise of definite, concrete functions. Thus, a municipal bureau of sewers is charged with constructing, repairing and supervising the city's sewer system; it must determine, independently or in conjunction with other city officials, where a sewer is to be built, how large and of what construction it shall be, must design it in detail, and must either carry out or supervise the constructive work; in general it must watch over and be responsible for the sewer system. Every part of this work: making and mapping surveys of sewers or of their drainage areas, making calculations and drawings for the sewers, establishing sewer grades, approving house connections, preparing specifications and awarding contracts for sewers, inspecting and approving their construction; is inherently the duty and sole privilege of the bureau, except as the legislative power superior to the bureau may withdraw certain of these functions by assigning them to other elements of the city government. With this limitation, these functions inhere in the bureau as an abstract machine, and are absolutely independent of the personal make-up of the bureau's force, being neither increased by superior nor decreased by inferior intelligence and energy of the employees. These are inherent or specific functions, with which the contents of the bureau's reports must be directly concerned.

Nearly every bureau, if it be not perfunctorily and mechanically administered, encounters and takes up, in the course of its specific work, certain accessory, minor, problems which, though not directly a part of its duties, affect the quality of its performance of those duties. Such problems are questions of improved method, of more exact knowledge than is available, or of special phenomena which may be observable in the course of the work of the bureau. The treatment of these problems is not one of the explicit duties of the bureau, but, in its relation to the latter, may properly be considered an implicit privilege.

Whether it shall be taken up, how thoroughly, intelligently or fruitfully it will be handled, depend wholly upon the caliber and quality of the men who make up the bureau. The results of such work will, in many cases, greatly facilitate the performance of the specific functions. The results per se, however, are generally abstract results; they do not constitute part of the executed work of the bureau, but are subjective and personal, in the sense that they derive their merit from the personal characteristics of the officials of the bureau. Such results we have, above, called by-products. An example will illustrate the term, and will at the same time exhibit some possible differences in its relation to public reports.

Suppose the sewer department of which we have above spoken were to find, in designing or building a certain sewer, that a novel form of sewer cross-section, applicable at that particular point but not generally in the city, would yield important advantages of efficiency or economy. The discovery of this form, and the analytical and practical study made to determine its applicability to the city's work, would then be of the class of by-product work. The fruits of this work, as far as contained in the sewer to which the novel form was applied, would be part of the bureau's completed performance of specific function. The sewer would, probably, be illustrated and described in an annual or special report of the bureau, and there also would be given a brief statement of the circumstances of discovery, and a reference to the work of investigation and the reasons for deciding to employ the new form. Beyond this, however, the work and its fruits would remain personal, not specifically belonging to the bureau, and (unless in exceptional cases) not proper subjects for official report by the bureau. After usual custom, the work and its scientific results would be made known to the technical world in some personal unofficial way, as by presentation before a technical society or in the engineering press. The utilization of the development in the sewer systems of other cities or in the designs of engineers would follow from this, and, like the publication of the novelty, would have no close relation to the single application made in the city of its origin.

But consider now a slight variation of the above case. Suppose that this new form of sewer cross section should prove, upon careful study by the

bureau, to be of general utility in the bureau's work; to be applicable to most or all of the city's future sewer construction, or, even, by application to the existing sewers, of great value in improving the entire sewer system of the city. In this case the brief passing statement of the discovery in the course of the annual report, as above sketched, would not be sufficient. It would become the duty of the head of the bureau to render special, full, report of the procedure as well as the results of the special by-product work to the administrative superior, together with such recommendations as may be indicated for the proper exploitation of the discovery in the city's work. This would be a report upon by-product work, either a special report or an appendix to a routine report; but though originating in by-product work, the rendering of this report with accompanying recommendations would, as soon as the wide applicability to the city's work became evident, become the duty of the bureau just as much as is the exercise of specific functions its duty. It is to be noted, however, that the personal character would still, to a considerable extent, inhere in the discovery. Being the fruit of the personal mental labor of one, two or a group of men, the privilege of announcing it to the technical world and also the duty of defending it against criticism, would remain with its originators as individuals. The publication in the bureau's report represented merely an announcement by the bureau to its employer, the city, of certain work done and certain official action taken in result; it can not be held to represent conclusions or opinion, but represents merely the objective result of the investigation. The subjective result and characteristics remain personal.

The preceding reflections may aid in distinguishing some general principles on what are proper subjects to be included in the public report of a public engineering department. Broadly, such a report describes work done. The work in question is either such as is done by the bureau in administering its specific functions, or it is an important piece of by-product work and has immediate bearing on the future work of the bureau. In detail, the report should describe the extent and nature of the individual items of work included, should state their origin, describe the organization and arrangement of the working corps and machinery, and relate the course and progress of the execution, describing also such special methods as have essential bearing on the efficiency of the work; lastly, it should state results as to cost and value, giving under the latter head the results of tests or working experience, etc. The range and amplification of this detail must depend of course in part upon the total amount of work to be reported, since a report should and can rarely be encyclopedic, or the equivalent of office-files. However, it is not often that doubt will arise as to the fullness of detail treatment; generally what question there may be is on the score of nature of matter to be included.

The essential character of a report is, as implied in all the preceding discussion, purely objective. Exceptions to this may appear, now and then, where a subjective statement of justification or explanation is called for by the administrative superior; but there will be no difficulty in recognizing such exceptions and excluding them from the range of the general rule. Excluding such, the reports of public engineering bureaus have the character simply of records: records of work done, or of action taken. Subjective matter is to be rigidly excluded. Matters of opinion, of criticism, of rejoinder, or of polemic controversy have no place in a public report. They are personal, non-negotiable; the report is the written record of the official bureau, an organization, a machine.

Two technical reports which have come before us within the past month may be instanced here as lending substance to the present discussion. They emanate from two of the many, almost infinitesimally split-up, engineering bureaus of the City of New York. One of them appears to violate in almost every particular the spirit of the present discussion, and, judged by the principles here set down, to be the very negation of a public engineering bureau's report; the other, excellent and cogent as far as it goes, fails if anything by omission of desirable detail, a fault which, as far as we know, may be due to limitation of available funds or time.

The first-mentioned "report" is a pamphlet bearing the title "Notes on Cement Testing; Additional Data Concerning the Relation between the Chemical and Physical Examination of Portland Cements," a report nominally made to the Mayor by the Commissioners of Accounts, but the text written by the engineer and the chemist of the Commissioners. In contents it is purely polemic, and —though its inherent excellence does not affect the question here raised—appears neither logical in arrangement nor conclusive in argument. The "report of the Commissioners" is a one-page introduction, which gives the following justification for the main body of the text:

> In our Annual Report to your Honor, on Page 60 of the printed copy, referring to our analyses of cement, we said:
>
> > All of the results of these analyses confirm the conclusions formerly reached in this office, and stated in the reports above-named, that Chemical Analysis, when properly conducted, confirms the results obtained in the physical examination of cements.
>
> The report herewith submitted, together with the Tables appended, will go far to prove the truth of this assertion, and we have no doubt that your Honor will approve of our purpose to print and circulate it.

The pamphlet as we read it does not throw much light on the questions which the Commissioners say it concerns. Be this as it may, what earthly connection there can be between the Commissioners of Accounts, the supervising book-keepers of the city of New York, and an abstruse chemical treatise on Portland cement, we are unable to understand. Nor can we any better understand why these commissioners require an engineer and chemist to conduct cement tests. But these riddles are not for our concern. The criticism which affects the pamphlet as a report is its absolute unsuitability for publication at the expense of municipal moneys, no matter how appropriate the engineering bureau, nor how closely its work might be concerned with cement testing.

On the face of the matter, the controversial, polemic character of the pamphlet makes it unsuited to its character as a public report. The test is introduced by a statement of purpose and contents as follows:

> We propose to discuss the determination of a method for a comparative analytical examination of cements, cement mortars and concretes correlative with their properties as revealed by physical tests. This very desirable undertaking has never before been proposed so far as we are informed.

It then proceeds to quote in extenso the methods for chemical analysis of cement as proposed by Carmichael, Richardson, Hillebrand, Blount and the committee of the American Society of Civil Engineers, and to criticize them. It outlines the modified method which the authors prefer, and presents some tables of results obtained with it. The polemic spirit of the entire pamphlet is best evidenced in the conclusions, ten in number, of which we quote the first and last:

> (1) That Prof. Henry Carmichael is correct in saying that "hydraulic cement consists of a double silicate of lime and alumina (including iron oxide), which is readily soluble in dilute hydrochloric acid, leaving little or no insoluble residue." That he is incorrect in grinding his sample fine in an agate mortar, p. 7.
>
> . . . . . .
>
> (10) That the method of analysis proposed by the authors of this report correlates the results of the analyses of cements, cement mortars and concretes with each other, and with the Physical Tests, as is shown in the results of the analyses set forth in Table D, p. 67; results that speak for themselves.

The "personal" character of the pamphlet, which we have previously made the criterion for excluding matter from a public report, is amply evident from these conclusions, and is sufficient to determine that the authors' dissertation has no business in a public report.

The further question: Whether it can be considered even legitimate by-product work of this bureau to investigate methods for chemical grading of cements, is also open to grave doubts. In the absence of definite knowledge concerning the proper work of the bureau, we can not venture an opinion on this question. But be the opinion as it may, we do not hesitate to assert that the results of such by-product investigation are, in the present state of the art of cement analysis and testing, too infinitesimally unimportant to the City of New York to warrant their publication as a report of a municipal bureau.

The other report referred to is the 1904 report of the Commissioner of Bridges, a very satisfactory statistical account of work done by the Bridge Department in the past three years.* The work of the department during this period included, as large items of work, the completion of the Williamsburgh Bridge, the design and redesign of the Manhattan Bridge, the design, reduction and contract award for the Blackwell's Island Bridge, and the planning and re-planning of the improved Manhattan Terminal for the Brooklyn Bridge, with the final adoption of a temporary makeshift terminal enlargement; a great mass of small bridge construction and repair work is also included. This vast amount of work involved a great many difficult and unusual problems of engineering, and covered many constructions of permanent interest to bridge engineers. It might be expected, therefore, that in this report would be put on record, by general drawings at least, the forms of construction that had been used, and special phases of the work of design or construction. Thus, one would expect to find general drawings, as full as might be, of the Manhattan and Blackwell's Island Bridges; of the deep pneumatic caissons which have been sunk for the tower foundations of the former; of the piers of the latter structure; sketches of the means and devices actually employed to repair the cables of the Williamsburgh Bridge where they were weakened by the fire on the west tower; a brief outline of the methods of calculation used in the design and redesign of the Manhattan (stiffened suspension) Bridge (a quite special and unusual piece of work); a plan of the Brooklyn Bridge terminal enlargement, etc., etc. But none of this material is given, probably because the statistical matter already made a bulky volume (308 pp.)

The argument of limited available space is, of course, unanswerable. We might suggest, however, that some 40 or 50 full-page insert plates showing photographs of various bridges under the jurisdiction of the Department could with profit have given place to some, at least, of the drawings and engineering data now lacking. And, again, were the administration of the city's engineering work centralized, as it should be, the money uselessly and improperly spent for the publication of the cement-test pamphlet, referred to just preceding, might have been usefully expended in enlarging the report of the Bridge Department.

*The administration period 1902-1903 is also included because no Chief Engineer's report had been prepared since the end of 1901.

CORRESPONDENCE.

Literature on Bridge Erection.

Sir: I read in your issue of Aug. 24 (p. 203) your remarks on the lack of literature on bridge erection. I feel with you that something on that special branch would be a valuable addition to what we already have on the general subject of bridge building.

Experience, common sense and versatility is a good combination. The bridgeman's versatility, however, does not extend to literature, so we need not expect him to produce any voluminous works on the subject under consideration; while the engineer is wont to regard erecting as something trifling and beneath his notice. This last is perhaps a one-man opinion, but I assure you there are grounds for it. I have frequently heard engineers of standing say: "Anybody can do that; every piece is marked and, the erector's copy shows where it belongs," or words to that effect. Still, in Engineering News there is something for all of us. Truly there is lots to be thankful for!

Yours,

Hugh Fourarre.

Sept. 11, 1905.

More Abuse of "Efficiency."

Sir: I was much interested in your editorial in the Engineering Literature Supplement which appeared with the issue of Aug. 17, concerning the indiscriminate use of the word "efficiency." A notable instance of this appears in the use of the word to express the ratio between the energy recorded by an integrating wattmeter and the true energy which it should record. Why this ratio expressed in per cent. is not called "percentage accuracy" I do not know, but the term "percentage efficiency" has become so general that it is found on the printed forms of large electric companies which maintain an extensive wattmeter checking department. The word seems to be especially objectionable and inapplicable from the fact that an integrating wattmetor is merely a form of electric motor, the real efficiency of which in the ordinary sense is utterly different from the ratio between its speed at any energy input to the speed which it should have to correctly record the energy in the circuit in which it is installed.

Very truly yours,

Hartley Le H. Smith.

Third Ave. & Second St., Brooklyn, N. Y., Aug. 19, 1905.

Criticisms of Inskip's Tables for Roof Framing.

Sir: I should like space for some comments on two books, the second of which was reviewed on page 404 of your issue of April 11, 1905. As noted further on, one of these books was published in 1904 and the other in 1905, but each bore on the title page, "Tables for Roof Framing, etc. By G. D. Inskip." My criticisms of the two books will be clearer after presenting the following by way of further introduction:

In the execution of detail drawing for steel structures the most general problem the draftsman has to deal with is, from the two sides of a right angled triangle expressed in feet, inches and fractions of an inch, one or all, to find the length of the hypothenuse and the bevel. A table of squares gives the former, but the latter involves the following roundabout series of operations:

(1) Reducing the given dimensions to decimals.

(2) Finding the ratio of the two sides, viz., the natural tan or cotan of one of the acute angles of the triangle.

(3) Finding the equivalent in inches per foot corresponding to the natural tan or cotan.

Operations 1 and 3 are generally performed with the aid of a table of decimal equivalents, while operation 2 is usually a process of direct division, since no appreciable saving of time would result in this case from the use of logarithms.

In 1901 the writer compiled a set of tables adapted to do with feet, inches and fractions of inches what has heretofore been possible, in the above and similar problems, with feet and decimals of feet only, or in other words, these tables substitute the United States system of measures for the metric system. This was accomplished by means of new principles, methods and systems discovered and applied by the writer and which are:

(1) A principle of computing logarithms of numbers when expressed in feet, inches and fractions of inches.

(2) A method of tabulating these logarithms, which gives a table of almost double the range of the usual logarithmic table of the same order.

(3) A system of tabulation wherein opposite each logarithm of a number is placed the square of the number in feet; or, in other words, the arrangement of these two elements in parallel columns.

The table of logarithms, with twelve as the base for inches, permits the handling of feet, inches and fractions of inches logarithmically in precisely the same manner as decimals. The extended range of the tables also practically eliminates the tedious process of interpolation. The parallel tabulation places the square and the logarithm of a number, often required together, side by side, permits the square of a number to be taken directly from its logarithm without first finding the number itself, or vice versa, and gives the logarithm of the square of a number by the simple process of multiplying the corresponding logarithm by two.

To illustrate the manifold application of these tables to the various problems met in practice would occupy too much space and carry us beyond the purpose of this article.*

Reverting to the particular problem to which this article relates, viz., the solution of triangles, the process with "Parallel Tables" is reduced to finding simultaneously the logarithms and squares of the given sides, then subtracting the former and adding the latter, and finally taking from the table the nearest numbers corresponding respectively to the sum of the squares and to the difference of the logarithms. The first result gives the hypothenuse and the second the slope or bevel.

With this brief glance at the field which Mr. Inskip has entered in the two books already mentioned let us see what these books contain and what they accomplish. In the first place, though different, they bear the same title, viz., "Tables for Roof Framing, Revised and Extended." Neither book refers to the other and neither indicates the time of publication, except in so far as the year of the copyright is noted in both to be 1904. The writer has ascertained, however, that one of the books was published in June, 1904, and the other in April, 1905, or thereabouts.

The "Tables for Roof Framing" (1904), contains tables of so-called perfect squares of feet, inches and 32ds of inches, from 0 to 50 ft., and feet, inches and 16ths of inches, from 50 ft. to 100 ft. Also logarithms of 32ds from 0 ft. to 60 ft. Also sines, tangents, etc. The 1905 "Tables for Roof Framing," advertised as tables of squares and logarithms, contain tables of squares of feet, inches and 16ths of inches from 0 to 60 ft., and tables of logarithms of feet, inches and 32ds of inches, from 0 ft. to 60 ft. Also sines, tangents, etc. The whole difference, therefore, between the two books is seen to be in the table of squares.

A closer examination of these tables of squares shows that the squares of the 1904 book are not the real or true squares of feet, inches, etc., or in other words, squares whose roots are numbers such as 3 ft. 9½ ins., but are merely the squares of common numbers, such as 10, 15, etc., which bear a constant ratio to the actual squares and should properly be termed "proportional squares." Further, these squares in Mr. Inskip's 1904 book are simply an extension of proportional squares appearing in a book called "Graphical and Analytical Roof Framing," stated to have been published by the same author in 1900.

In the 1904 book these proportional squares occupy 300 pages, 6½ × 7½ ins. in size, and owing to their nature they could not be otherwise than poorly arranged. It is true that they afford a means of solving in an indirect manner some problems which are handled directly by means of a table of true squares, but by no means all of them. They do not, moreover, serve the elementary purpose of a table of squares of feet and inches; that is, to find the square of a number such as 25 ft. 6½ ins. Coming as it does, long after the publication of "Buchanan's Tables," and especially Mr. Hall's excellent work, it is difficult to see just why these tables were published. That the author realized the futility of a table of proportional squares is evidenced by the publication of his 1905 book, in which the proportional squares are discarded and replaced by a table of true squares, apparently taken directly from Mr. Hall's book without due credit being given.

Nothing is said in this 1905 book about the proportional squares, in 16ths and 32ds, of the 1904 book, but the true squares of Hall are treated as a revision and extension of proportional squares in ⅛ths of the 1900 book, the statement being made that the difference between the two kinds of squares is that the true squares are expressed in decimal form. This is incorrect and confusing, because proportional squares can be expressed in decimal form and still remain proportional squares. Mr. Hall's squares have been slightly modified by Mr. Inskip in respect to the number of decimals, but in the opinion of the writer this modification detracts from the appearance of the book, and instead of bettering the work of Hall has impaired its uniformity and completeness.

In similar manner Mr. Inskip has embodied in both his 1904 and 1905 books logarithms from the writer's "Parallel Tables,"* which seem to have been used just as they are; even the arrangement and the peculiar setting of the type adopted by the writer having been retained unchanged. The tables have, however, been extended from 50 to 60 ft. and in the ten pages covered by this extension the writer has found not less than 35 or 40 errors, which do not appear in the portion from 0 to 50 ft. Many of these errors are of such a nature as to leave no other inference than that the extended portion was an imperfect imitation of the original tables, while the other portion was a direct copy.

From the above it is evident that Mr. Inskip has effected a heterogeneous combination of Hall's "Tables of Squares" of 16ths, and of the writer's "Tables of Logarithms" of 32ds, in which not only are the logarithms and squares separated from each other, but, in addition, the variations in the one are twice what they are in the other. This practically destroys the value of the book to the user, who is thus compelled to adjust the differences, and is in entire contrast to the particular feature which the writer sought to accomplish in his "Parallel Tables."

C. Smoley, C. E.

Chicago Opera House Block, Chicago, Ill., July 1, 1905.

Sir: I am in receipt of your letter containing proof of Mr. Smoley's criticism of Inskip's "Tables" and thank you for the courtesy extended. Mr. Smoley is wrong in assuming that my tables were copied either from his book, that of Mr. Hall or any one else. All the computations were made by me from the formulas given in the book. The style of type, arrangement, etc., were adopted from Schron's "Logarithmic Tables," a German publication, bearing date of 1865. I had not seen books of the above authors till my publisher forwarded them to me with the suggestion that I should extend my tables to 100 feet by 32ds for both squares and logarithms, inasmuch as no book on the market was carried to that point. This I have done. There are several statements made in Mr. Smoley's letter, which, had he looked into the subject more carefully, perhaps he would not have made. I do not consider it proper for me to take up your valuable space with a full discussion of these points. Any fair-minded person who examines the two books side by side will see the absurdity of Mr. Smoley's claims.

Very truly yours, Geo. D. Inskip.

410 North 58th St., Philadelphia, Pa., Aug. 30, 1905.

Sir: Your letter enclosing Mr. Inskip's reply to my criticism of his "Tables for Roof Framing" has been duly received and I thank you for the opportunity furnished and beg to state:

Having examined in the Chicago Public Library a copy of Schron's book, referred to in Mr. Inskip's letter, I find that it is a seven-decimal logarithmic-trigonometric table similar to Vega's or Bruhn's, and that there it contains nothing that Mr. Inskip could follow in his arrangements of his tables of logarithms and squares of feet, etc.

Any one not experienced in the printing profession will easily take Mr. Inskip's tables of logarithms to be photographs of the logarithmic columns of the writer's "parallel tables;" and only a blind man will fail to recognize the main features of the arrangements of Mr. Inskip's tables of squares as those of Hall's tables.

As to the formulas for figuring logarithms, squares of feet, etc., given in Mr. Inskip's book, an examination of them shows that they are those discovered partly by Mr. Hall and partly by the writer.

C. Smoley, C. E.

Chicago, Sept. 5, 1905.

A New Edition of Merriman's Mechanics of Materials.

Reviewed by W. K. Hatt.*

MECHANICS OF MATERIALS.—By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. Tenth Edition, rewritten and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 507; 20 tables and 183 figures in the text. $5.

Engineering literature contains compilations of data which have been prepared by active and industrious persons who do not possess in any considerable degree either the experience or the critical frame of mind necessary to separate the significant results from those that are confused and confusing. Such books do not add much of value to the volume of scientific literature. In contrast with these is Professor Merriman's "Mechanics of Materials." It is with a feeling of thankfulness and relief that one welcomes the result of his conscientious and critical scrutiny of experimental data and his abstraction therefrom of principles.

The tenth edition of Professor Merriman's "Mechanics of Materials" is practically a new book. The same clearness and accuracy of statement, the same natural sequence of development of principles, the same sense of proportion in alloting space to various topics that marked his earlier editions of this book characterize the present edition. New topics have been introduced, and the treatment of those in earlier editions has been perfected. The author has digested the mass of existing experimental data, both domestic and foreign, and has brought it into proper relation to the fundamental principles of mechanics. This great task has been thoroughly performed.

For instance, in addition to presenting the well known early experiments on the fatigue of metals, and representing these by formulas for the strength of materials under repetitive stress, the experiments of Turner in measuring thermal changes taking place in steel under stress, and the work of Tresca, Hartmann and Rejto on internal friction, are discussed in the light they throw on the phenomena of fatigue of metals under such stresses. Again, from the theory of internal friction a relation is reduced between the shearing and compressive strength of materials. It appears, for instance, that the shearing strength of concrete should be nearly three-tenths of the compressive strength. The relation between angle of rupture under compressive stress and brittleness of material, as shown on page 45, is novel and useful. Again, a reasonable and conservative estimate is made of the significance of late investigations of reinforced concrete. A glance at the index will show the wide range of this review of data.

Standard cases of stress are analyzed and unusual topics are found, such as eccentric loads on columns; non-circular sections of shafts; eccentric axial loads on beams; non-symmetrical loads on beams; principle of least work; internal friction; elastic-electric analogies; and an entire chapter on compound beams and columns, including flitched beams and reinforced concrete beams.

The book is mainly intended for students in engineering colleges, but it will serve as an excellent reference book for the practitioner who has constantly to refer to fundamental theory for guidance in new fields of thought. Indeed, the practitioner in these days of new forms of construction, like reinforced concrete, must become a student. It is not to be expected that the physical and mechanical properties of ma-

*Those who wish may refer to the examples given in the "Parallel Tables" themselves, also to an article by Mr. F. D. Davis, entitled "Smoley's Tables—Some Convenient Methods by Their Use," published in Engineering News, Dec. 25, 1902.

*"Parallel Tables of Logarithms and Squares of Feet, Inches, and Fractions of Inches Varying from 1-32-in. to 50 ft." By C. Smoley. Second Edition, 1902. New York: Engineering News Publishing Co.

*Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

terials quoted in a book of this kind will suffice for use of an expert in steel or cement. The selected constants are, however, well chosen averages; and the variations to be expected for different classes of any one material, and in individual specimens of the same class, are stated by the author for the warning of the student. Chapter III., which contains a short account of the manufacture and qualities of various materials of construction, will give the student concrete ideas that will serve as a skeleton upon which he may hang more detailed knowledge.

The author's method of presentation will suit the mental development of the student. For instance, in presenting the subject of moving loads, he discusses the case of two equal loads to show the student that the most dangerous position is not when the center of the loads is at the center of the span, but is an unexpected position. The student is then ready to follow the general case with more curiosity and interest. The author is careful to introduce concrete conceptions of the various bodies analyzed before proceeding to the mechanical analysis, and follows the latter with a discussion of the limitations of the application of the resulting formulas and their usefulness in design. The historical notes are interesting and of value from an educational standpoint. Particularly noticeable from the student's standpoint are the definitions of the relations of such properties as elasticity and brittleness. The author's warning as to the limit of accuracy of data seems to be needed in view of the tendency of engineering students to work out answers to problems to several significant figures when the data entering into the problem are accurate to only one per cent. The problems are such as to stimulate the thought of the student, and many of them present considerable difficulty. Food for advanced classes will be found at the end of the volume, where the treatment of the effect of inertia in modifying stress experienced under impact, mechanics of guns, flat plates, and the mathematical theory of elasticity are discussed, not entirely as problems of mathematics, but concretely, with an eye on the actual material. The trigonometrical treatment of the mathematical theory of elasticity seems to the reviewer better suited to the author's readers than the use of the differential calculus.

It is evident that the author has little sympathy with the endeavor to deduce formulas for the moment of beams when loaded beyond the elastic limit by Considére's method, which consists in applying stress-strain diagrams to the cross section of the beam. The author uses the ordinary formulas, and then modifies these by experimental constants. He says:

> For materials like cast iron and concrete it is possible to deduce formulas which apply more closely than a common flexure formula, by using a parabola instead of the straight line to represent the variations of stress above or below the neutral axis. These formulas include constants which give the relation between stress and deformation so that each material requires a different flexure formula. Although such formulas are theoretically more correct than for stresses beyond the elastic limit, it does not appear that they give better results for rupture than are obtained by using [the common flexure formula — W.K.H.] with the values of [the modulus of rupture of similar pieces—W.K.H.] found by experiment.

The various elements entering into the factor of safety are mentioned, and the author states that it is now considered the better plan in judging of the degree of security of the body under stress to consider the elastic limit of the material.

The author introduces the topic of reinforced concrete in Chapter XII., "Compound Columns and Beams." The fundamental conceptions are developed by reference to axial loads on columns composed of different materials, and the shares of the load carried by the individual elements are seen to depend on their respective moduli of elasticity. The example of the reinforced concrete column is chosen; the usual forms of construction described, and a simple method of calculation developed, followed by some critical discussion of the construction. A discussion of flitched beams of wood and steel leads to the reinforced concrete beam. The treatment of the latter is simple and in accordance with fundamental theory. The case in which the tensile stresses in the concrete are included in the moment of figures is first considered; afterwards the formulas are developed for the cases in which these tensile stresses are omitted. The method of computation for design recommended by the author omits these tensile stresses of concrete and supposes a rectilinear stress-strain relation between the stresses on the concrete in compression.

It would seem that failure by longitudinal shear, followed by rupture along a curved surface running from the support toward the load, is of more frequent occurrence in experiments than the language of the author would seem to indicate. The necessity of computing longitudinal shear acting along the reinforcing material very often exists. The author has used the terms reinforced concrete and concrete-steel apparently without distinction. Particularly valuable for the purpose of the student are the descriptions of the phenomena of failure of reinforced concrete beams, and the statements concerning the general characteristics of design of such beams.

The book is so nearly an ideal treatise that no considerable criticism can be sustained. There are, however, some minor points in which the text might be improved. For instance, on page 6, the definition of ultimate strength should make plain the fact that the actual unit stress is not computed, but that the area entering into the calculation is the original area of the bar and not the reduced area. For the sake of completeness the common transformation formula for moment of inertia between parallel axes should be given with the text on page 108. The discussion of horizontal shear in beams might well appear along with the discussion of the fundamental theory of beams instead of being placed in article 108. Some fuller treatment of the mechanics of spiral springs and carriage springs would be of advantage, for it is difficult for the student to understand the connection between these cases and the ordinary formulas for shafts and beams. Discussion of the case of torsion, because of its simplicity, might well appear earlier in the volume. In the treatment of beams fixed at both ends a fuller description might be given of the physical conditions of the ends in order that these may fulfill the theoretical requirements. The statement on page 53 that the shearing strength of cement or mortar is one-third to one-fourth its tensile strength is probably a misprint, since it is in conflict with the relation quoted on page 380; the word tensile is probably a misprint for compressive. The definition of concrete on page 24 should be modified to include the use of aggregates of gravel, cinders and slag. The sentence descriptive of good timber, on page 46, would rule out many good structural timbers.

There is an opportunity for difference of opinion as to the advantage of extensive figures and diagrams. The treatise under review offers a contrast in this respect to such treatises as Church's "Mechanics of Engineering," Weisbach's "Mechanics of Machinery and Engineering," and Poncelet's "Cours de Mecanique." These three last-mentioned treatises attempt to present more of a picture of the object under consideration, whereas Merriman's figures are more diagramatic and leave more to the imagination. Church, for instance, is careful to show the origin of the co-ordinates, the system of forces in equilibrium acting on part of the body under consideration. Merriman presupposes a better working knowledge of engineering mathematics than does Church. In the reviewer's experience students seem to thrive on either text. Much must be left to the administration of the subject by the class room instructor in either case. Merriman's text is more complete and better arranged with respect to the fundamental properties of materials of construction than Church's Mechanics, and with respect to the critical discussion of the limitations of the formulas and the presentation of the fundamental ideas as distinct from the mechanical analysis. Indeed, Merriman's book is the equal of Cotterill's "Applied Mechanics" in this respect, while it is an easier book for students to follow. The presentation of data in Merriman's book does not pretend to be as complete as that contained in Lanza's "Applied Mechanics." The data in Lanza's book are, no doubt, better suited for the practitioner than for students of mechanics of materials. Merriman's book rivals the French treatises in clearness of expression and development of ideas.

It is to be noted that the author does not attempt to present the theory of structures as do Lanza and Bovey, although it would seem as if the fundamentals of the mechanics of arch ribs might be presented with advantage. Nor are the graphical methods of determining the deflection and stresses in irregular shaped beams touched upon in Merriman's book. The author has no doubt had these matters in mind in making up the text.

Before closing the review the author's words on page 20 may be quoted:

> It will be necessary for students, in order to gain a clear idea of the mechanics of materials, or of any engineering subject, to solve many numerical problems, and in this work a neat and systematic method should be followed. The practice of making computations on any loose scraps of paper that may happen to be at hand should be discontinued by every student who has followed it, and he should hereafter solve his problems in a special book provided for that purpose, accompanying them by explanatory remarks. Such a notebook, written in ink, and containing the solutions of the problems given in these pages will prove of great value to every student. Before beginning the solution of a problem, a diagram should be drawn whenever possible, for a diagram helps the student to understand the problem, and a problem thoroughly understood is half solved.
>
> Before beginning the numerical work, it is also well to make a mental estimate of the answer and record the same, comparing it later with the result of the solution, since in this manner the engineering judgment of the student will be developed.

There are few limitations to be placed upon the enthusiastic praise with which the reviewer regards this notable addition to engineering text books and engineering literature. It will, in the words of the author, advance the interests of sound engineering education and promote sound engineering practice.

W. Osborne, in "American Machinist," August 3, 1905, in an article entitled, **"Some Things Found in a Hand-book:"**

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New York Hydrology.

Reviewed by Daniel W. Mead.*

HYDROLOGY OF THE STATE OF NEW YORK.—By George W. Rafter. Bulletin 85, Economic Geology 12, New York State Museum. John M. Clarke, Director. Albany, N. Y.: New York State Education Department. Cloth; 6 x 9 ins.; pp. 902; 90 tables, five folding maps (two in pocket), 45 plates and 74 figures in the text. $1.50.

Hydrology in its engineering aspect may be defined as that science which treats of those physical facts and phenomena which directly or indirectly influence the distribution, conservation and utilization of water.

Every science in its broadest extent includes, for its correct and detailed understanding, all other sciences. It is impossible to prescribe fixed limits where it may be said that one science ends and another begins. Each not only encroaches on the domains of the other, but at the extreme limit actually includes it. So with the science of hydrology, the limitations cannot be closely drawn, but must be sufficiently extended to render the subject fairly complete in itself. The encroachment of one science on the domains of another, when such sciences are regarded in their ordinary restrictive sense, is, however, less than at first seems apparent, for while similar subject matter may be considered under each subject, nevertheless such matter is, or should be, considered from quite different points of view.

In both meteorology and hydrology the consideration of meteorological phenomena, especially of atmospheric moisture and of rainfall, is important. Meteorology, however, treats of these subjects as natural phenomena that have to do with other meteorological and climatic conditions, and considers them mainly in such relations. Hydrology, on the other hand, considers the circulation of water on the earth's surface as of itself the important phenomena and studies other meteorological and climatic conditions as controlling or modifying this important central fact. So also geology and hydrology must both consider the subjects of surface and underground waters, but each from an altogether different standpoint. Geology examines these relations with regard to the dynamic influence of water on the formation and past and present conditions of the geological deposits themselves. To this science water is the active agent, which, in the solid, liquid, or gaseous state has largely modified, molded and formed the crust of the earth as it now exists. Hydrology, on the other hand, examines the same facts, but from an entirely different aspect. The hydrologist investigates the nature of the strata with regard to their conditions as influencing or controlling the distribution and circulation of water, and its chemical and physical character. So with the various other phases of this subject, the study and investigation of the hydrologist is ever with water as the central fact, and all other facts and conditions are regarded, for the most part, only in their modifying relations.

While hydrology cannot be regarded as a new science, yet its treatment has been largely fragmentary, and few attempts have been made to consider the subject in a systematic and comprehensive manner. Many of its phases have been long considered and extensively discussed. Many of its various branches have been extensively investigated, and have been treated by various writers in a manner both creditable and fairly complete. Few attempts have been made, however, to correlate these subjects and to discuss them in their broad and mutual relations. The literature of the subject is therefore widely scattered. Treatises on physical geography, geology, meteorology, and engineering often contain much of direct value on phases of this science. The proceedings of technical and other scientific societies have contained many and valuable contributions on special aspects of hydrology. Many reports, published and unpublished, have treated in a more or less thorough manner local hydrographic conditions as influencing special projects. Yet while there is no part of the field of this science which has not been covered in a more or less satisfactory manner, still the difficulty of access to these special sources of information, and the lack of a thorough discussion and correlation of the branches constituting this science, has rendered it difficult to acquire a broad and comprehensive view of the subject, or to appreciate the importance of such a knowledge to the correct conception, design, and execution of many of the problems of hydraulic engineering.

Only a brief consideration of hydrology is necessary in order to establish the fundamental value of this science to the engineer. Innumerable failures, more or less complete, of ill-advised hydraulic works point to the fact that their designer was ignorant of the fundamental hydrological data, a knowledge of which would have meant either success or the abandonment of unfeasible projects.

The histories of public water supplies, and, in fact, the present condition of many of the water supplies of the municipalities of this country, point emphatically to the necessity of a greater knowledge of the fundamental principles of this science. Water power developments, irrigation and drainage works, canals and river improvements all furnish examples, well known to every observing engineer, of failures due not to constructional features but to elementary hydrological conditions which have been ignored or unappreciated in the conception of the project. Such errors are fundamental, and should be corrected in the education of the young engineer. The failure to do so has been largely due to the lack of any systematic treatise on hydrology.

The importance of this fundamental knowledge has long been appreciated by those engineers brought more directly in contact with the solution of the problems in which these relations are of the most importance. In 1850 Nathaniel Beardsmore issued the first edition of his hydraulic tables, which included some matter concerning rainfall, the flow of springs, and other hydrological data. This book was largely augmented in the second edition, published in 1851, and was entirely rewritten, rearranged, extended and published under the title of "Manual of Hydrology," in 1862. This manual, which is long since out of print, was divided into four parts, including: (1) Hydraulic and other tables; (2) rivers and flow from large districts; (3) tides; (4) rainfall and evaporation. Under these divisions was included a large amount of valuable data from various parts of the world, and a discussion of the same, which showed a very complete appreciation of the elements of the problems considered. This was the first English treatise in which an attempt was made to segregate the fundamental data of hydrology.

Since the issue of this work no such broad or general treatment of the subject has been attempted. Many special papers and reports covering more or less completely the main hydrological data of restricted areas have, however, appeared from time to time. In 1888 the U. S. Geological Survey began the study of the streams and waters of the United States, rightly considering them as among the most important of the geological resources of the country. In the seventeen years which have since elapsed, this work has been gradually extended, and the number of observers now at work under the direction of the Geological Survey is very large and the annual contribution of hydrological data by the Survey is large and important. The results of this work have been published in the form of various monographs and papers in the Report of the Director and in the form of what are known as Water Supply and Irrigation Papers, of which about 130 have already been issued.

In addition to the work of the U. S. Geological Survey other work of considerable importance has been done by the U. S. Government and by various states. The two volumes on Water Power, which formed a part of the Tenth Census of the United States, contain much data of value. Various states have also undertaken work of considerable importance. Among the first of these publications may be mentioned the volume on the Water Powers of the State of Maine, by Walter Wells, was published in 1869. Humphrey & Abbott's treatise on the Physics and Hydraulics of the Mississippi River, published about 1862, is also worthy of special note. The work of the Mississippi River Commission, and of the Engineers of the United States, covering investigation of the flow of rivers, and of the Great Lakes in relation to the improvement of navigation, deserves more than mere mention. Much of value, however, lies hidden and unappreciated, on account of the mass of material annually published in the report of the Chief Engineer.

All these, however, cover only special phases of the general subject, and point out only a few of the many mutual relations of the various sciences to the science of hydrology.

The State Geologist of New Jersey has published considerable information in regard to the water resources of the State in their various relations in his annual report. The most important New Jersey publication, however, is the report on water supply, water power, and the flow of streams and attendant phenomena, by C. C. Vermeule, published as Volume III. of the final report of the State Geologist of New Jersey, in 1894. Mr. Vermeule's treatment of the subject was broad, and the issue of this volume was therefore of more than local importance.

The State of New York has, in recent years, carried on a more complete investigation of its water resources than has been done by any other State. This is doubtless due largely to the fact that New York has been the main highway of com-

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APPENDIX.—Elements of Design favorable to Speed Regulation in Plants driven by Water Power. By Allan V. Garratt.—Index.

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merce from and to the West, and early conceived and constructed an extensive canal system, which aided materially in its development. On account of its early settlement, attention was soon drawn to its water power resources, which have long been utilized to a limited extent. The increase in commerce and the necessity for providing more extensive facilities for water carriage between the great lakes and the sea coast have also drawn especial attention to the water resources of New York State, and these have been extensively studied with reference to their availability to supply the water necessary for feeding the summit levels of such canals, both by the State and by the U. S. Deep Waterway Commission. Much of this work has been done under the direction of the State Engineer and Surveyor, while many special subjects have been investigated by commissions specially appointed for such purposes.

Mr. George W. Rafter, the author of the treatise under review, has long been connected with this important work. Many of the important investigations in regard to storage and water supply projects have been carried out directly under his supervision. He, therefore, brought to the consideration of this subject an extended experience and a vast fund of information acquired both in his public and private practice.

In this treatise, Mr. Rafter has gathered together from many sources a large amount of data, some of which have been previously published, but are now more or less inaccessible, together with considerable new material collected by him. Much of the older material has been revised and rearranged in a manner to facilitate its use, and to render it of the most value. This is especially noticeable in the arrangement of the tables of rainfall, temperatures and stream flow, which have been rearranged with reference to the water year, beginning with December and ending with November, which rearrangement in itself represents a work of considerable magnitude.

The basis of this treatise was two papers on the Water Resources of the State of New York, prepared by Mr. Rafter, and published as Water Supply and Irrigation Papers, Nos. 24 and 25, of the U. S. Geological Survey. With these are combined data from the report of the State Engineer and Surveyor of New York, the Superintendent of Public Works, the Forest Commission, the State Board of Health, and the State Weather Service, together with many other data personally collected by Mr. Rafter. Considerable information was derived from the Report of the Board of Engineers of Deep Waterways; also from the investigation of the water supply for the enlarged canal through New York State, from the Water Storage Commission of 1902; also such portions of Water Supply and Irrigation Paper No. 80, on the Relation of Rainfall to Run-Off, as applies to the State of New York.

The subjects are treated in their logical order. The general question of the water resources of the State and their value are briefly discussed. Following this is a brief discussion of the climatic data of the State, which, in turn is followed by a lengthy discussion of the relation of rainfall to run-off. Under this general heading, the rainfall in the State, the resulting run-off, and the influence thereon of evaporation, of forests, and of other minor influences are quite fully described.

This is followed by descriptions of the river systems of the State of New York. These descriptions include a discussion of the drainage area and their physical features. The present developments of water power on each stream are also briefly described. The stream gagings carried on by mutual arrangement between the State of New York and the U. S. Geological Survey are discussed, including the discharge measurement of various New York rivers. The run-off in cubic feet per second, cubic feet per second per square mile, and in inches on the drainage area, are given for each month and for each water period for each year during which observations have been made up to and including 1901. The maximum and minimum flow of streams is quite thoroughly treated, the discussion of the flood flow of the Genesee River being especially complete.

The question of the development of water power in New York is considered in its historical and legal aspect.

The possibilities of storage on many of the rivers of the State and the value of such improvements are discussed. Water power developments which are of sufficient importance for special description are briefly treated. These descriptions include the plants at Niagara, those on the Hudson River and St. Lawrence River, and also the Erie Canal. The history of New York water supply, which is one of the questions of great interest and importance to a large number of citizens of the State, receives considerable attention, and is discussed both in its historical aspect as well as its possible future development. The inland water ways of the State, both in their historical and engineering bearings, are considered, as is also the various ship canal projects and their water supply. Municipal water supplies in western New York receive brief notice, and short discussions are given on the selling price of water power, loss of water from artificial channels, the drainage of swamp areas in New York, the paper industries of New York and various other matters of interest in this connection.

The book closes with a bibliography of works referred to in the preparation of the hydrology of New York.

Mr. Rafter has collected in this volume a large amount of valuable information on this subject, much of which is not only of value to the citizens of the State, but will be of almost equal value to others interested in this general subject. While this work is voluminous, it covers only those phases of hydrology which are most directly connected with the water resources. Taken, however, together with the physical geography of the State of New York, by Prof. Ralph S. Tarr, the engineer is afforded the most complete discussion of the hydrology of a State that is anywhere available. Mr. Rafter calls attention to the fact that the limits of even this extended publication have not been sufficient to permit of the elaboration of all the available data. The selection of data, however, seems to have been most judicious, for the leading and most important matters are quite fully considered and further details of importance to those particularly interested in a special subject can well be left for their investigations in the special papers and reports available.

STANDARD METHODS OF TESTING AND SPECIFICATIONS FOR CEMENT.—Edited by the Secretary, under the direction of Committee C on Standard Specifications for Cement of the American Society for Testing Materials. Philadelphia, Pa.: The Committee (Richard L. Humphrey, Secretary, Harrison Building). Paper; 6 x 9 ins.; pp. 32; five figures in the text.

This pamphlet contains the latest reports of the committees on (1) Uniform Tests of Cement; (2) Standard Specifications for Cement, and (3) Uniformity in Methods of Chemical Analysis for Limestones, Raw Materials and Portland Cements. As will be recalled by most of our readers these committees were appointed respectively by the American Society of Civil Engineers, the American Society for Testing Materials and the New York Section, Society for Chemical Industry. An introduction rehearses briefly the origin and personnel of the several committees; then follows the three reports in the order named above. All these reports will be found published in recent issues of technical journals, but the present pamphlet gives them in one place and in convenient form for use.

IRRIGATION IN THE WESTERN UNITED STATES.—By R. A. Van Sandick, Secretary of the Royal Engineering Society of Holland and Editor in Chief of "De Ingenieur." A paper read at the meeting of the International Colonial Institute held at Rome, April 25, 1905. Brussels, Belgium (36 Rue Veydt): Institut Colonial International.

The author of this paper, Mr. Van Sandick, may be remembered by some of our readers as one of the delegates from Holland to the International Engineering Congress held at St. Louis a year ago, where he delivered a brief address at the closing session. He had at that time just returned from an extended visit to the irrigation works of the West, and the pamphlet under notice gives the result of his observations of American irrigation practice. There was an extended discussion of the paper. The pamphlet is printed in French.

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Reviewed by Henry S. Jacoby.*

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In 1903 the copyright was renewed for this work, which has served as a text-book in stereotomy since 1875. The text of the latest issue, which is marked "fourth thousand," is apparently printed from the original stereotype plates, but the folding plates are printed from entirely new cuts made by the wax process, and are therefore much more legible than the old plates. They are also placed together at the end of the volume, thus being more convenient for reference than in the former arrangement, in which they were scattered through the book.

The contents of this work are so well known that it is not necessary to give a detailed description. The choice of most of the exercises and the general form of the drawings followed the French works on this subject, although the method of treatment was altered in some respects. While the examples given answer their purpose very well in showing the application of descriptive geometry to the construction, together with the form and use, of patterns and other directing instruments needed to cut the stones, no complete working plan is given of any masonry structure to show the student the manner in which such drawings are prepared in modern practice.

There was practically no other American textbook on stereotomy available until 1896, when "Modern Stone Cutting and Masonry," by Siebert and Biggin, appeared. This supplied examples of modern working drawings for a 6-ft. arch culvert, a 12-ft. arch, an abutment, a pier, a canal lock; and some details of a tower door, entrance and port cochere of a building. Only three of the problems given by Warren were, however, included in the text, and the entire text was contained in 46 heavily leaded pages with less than one-fourth as much matter as in the older book.

In 1902 "Stereotomy," by French and Ives, was issued. This is a thoroughly modern work, both in subject matter and illustrations. The latter include masonry plans for a number of actual structures and some of the practical details of building stone masonry. The text has ix. + 119 pages, and there are 22 folding plates. It was reviewed in the Engineering Literature Supplement of the Engineering News for Jan. 15, 1903, to which the reader is referred for full information.

INSULAR AND MUNICIPAL FINANCES IN PORTO RICO FOR THE FISCAL YEAR 1902-3.—Bulletin 24, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 x 11½ ins.; pp. 31.

The larger and more interesting part of this bulletin deals with the municipal finances of Porto Rico. To make those intelligible the reorganized municipal government is described. The 66 "municipios" which existed under Spanish rule have been reduced to 46 by consolidating 20 of the weaker ones with some of the larger districts. The municipal areas include rural as well as urban districts, which is particularly suitable in Porto Rico, where many of the rural land owners live in the towns.

The two most distinctive and commendable features of the Porto Rican municipalities is their large measure of home rule on the one hand, and their centralized control by the government on the other. The latter, however, relates chiefly to police, education and highways, which are after all matters of the commonwealth rather than the locality. The most notable feature of central control is the provision for uniform municipal accounting, under the direction of the Treasurer of Porto Rico. By the adoption of this measure, as stated in the bulletin, "Porto Rico has put itself in the front rank of commonwealths which are moving forward in the direction of better municipal government."

*Professor of Bridge Engineering, Cornell University, Ithaca, N. Y.

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The Manufacture of Cements, Limes and Plasters.

CEMENTS, LIMES, AND PLASTERS.—Their Materials, Manufacture, and Properties. By Edwin C. Eckel, C. E., Assoc. Am. Soc. C. E.; Member Society of Chemical Industry, Assistant Geologist, U. S. Geological Survey. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 x 9 ins.; pp. 712; 165 illustrations, mostly in the text, and 254 tables. $6, net.

Technical literature has long lacked an adequate treatise on the manufacture of cements, limes and plasters. Mr. Eckel's book, it seems to us, comes as near to filling this void satisfactorily as could be expected of a single volume of moderate size. It is true that the author discusses the properties of cementing materials, but he gives the subject a subordinate position. The book is essentially a treatise on the technology of cement manufacture, cement here being used as a generic term for the various lime products and plasters, as well as for the true hydraulic cements. In its particular field the volume stands alone in the English language, and a somewhat more than casual knowledge of French and German cement literature fails to call to mind any treatise of equal scope and thoroughness. It is deserving of note, moreover, that the book is essentially American, foreign materials and foreign practice being made supplementary to American in the discussions.

In an introduction the author refers to the growth of the cement industry in America and points out its present commercial importance. He then proceeds to divide cementing materials into two groups: (1) simple cementing materials, including plasters, lime and magnesia; (2) complex cementing materials, including the hydraulic limes and cements and oxychloride cements. This classification is explained in sufficient detail to establish the reason for making it. There follow two sections presenting chemical and physical data such as atomic weights, chemical compounds, heat units, and metric conversion tables, employed in the discussion of cementing materials.

The first five chapters of the book are devoted to the cementing materials (plasters) made from gypsum, taking up first the composition, distribution and mining of the raw material, and following with chapters on the manufacture of the various plasters, on their properties, and on the statistics of the gypsum and plaster industries. It is interesting in this connection to note that the United States stands second only to France in the amount of gypsum produced yearly. Plasters are divided by the author into two groups, those produced by the incomplete dehydration of gypsum and those produced by its complete dehydration. The first group includes plaster of Paris and "cement plaster," and the second group the so-called flooring and hard finish plasters. The greater space is properly given to the plasters of the first group, two chapters being devoted to them, one to their manufacture and one to their properties, as determined by numerous quoted tests. In discussing the manufacture the physical reduction of the gypsum is first described and then its calcination; the oven process, kettle process and rotary cylinder process are considered in the order named, and then follows a discussion of the addition of retarders and accelerators and the presentation of general figures of cost. Of the second group of plasters only the hard finish plasters are made in the United States. For flooring plasters the author has recourse to German practice; they are not made in America. American hard finish plaster manufacture is briefly but adequately described.

The second broad division of the author's subject includes limes and lime products—hydrated lime and the newly revived product, lime-sand brick. In the first chapter (VI.) the origin, composition, varieties and chemical and physical compositions of limestones are discussed. The chapter following describes the process of lime burning, and gives statistics of the industry. The chapter is particularly full in its descriptions of kilns and its figures of cost. Chapter VIII. discusses the chemical and physical properties of lime and lime mortars. Hydrated lime manufacture is given a chapter by itself. The chapter on lime sand brick is a condensed summary of recent periodical literature on the subject.

The production of magnesia, or magnesium oxide, from magnesite and from magnesium limestone is described in Chapter XI. Magnesia, while an excellent cementing material, is too costly to be used for structural purposes as mortar, but it has an important use for magnesia bricks and for the so-called oxychloride cements which form the cement element of Sorel stone and other artificial stones. These products are considered in Chapter XII.

Part IV., including Chapters XIII., XIV. and XV., are devoted to European hydraulic limes. The subject is rather briefly treated, but considering that these limes are unknown in the United States, they perhaps receive all the consideration that they deserve.

With Part V. of his book the author arrives at the true hydraulic cements; six chapters are devoted to natural cements, which are considered first. A preliminary chapter defines natural cements and explains their relations to limes and to other hydraulic cements. This is followed by an excellent chapter on raw materials, considering first the American natural cement rocks and giving their character and occurrence by States. The European natural cement rocks are then similarly discussed, and then follows a rather brief section on mining and quarrying methods. In the chapter on manufacture calcination and kilns are first described, then the seasoning of the clinker, then various processes of crushing and grinding the clinker and separating the fine material. The chemical and physical properties of natural cements are discussed in Chapter XIX., and the following chapter gives a number of typical specifications for such cements.

To the important subject of Portland cements the author devotes 19 chapters, taking up in order the history and statistics of the industry, raw materials, reduction of raw materials, calcination, clinker reduction, packing, storing and shipping, cost of manufacture, and constitution, properties and composition. There are chapters on requisites and treatment of kiln fuels, on heat consumption and utilization, and on specifications and tests. To review in detail the contents of this section is impracticable within the space at command; the section is a book in itself, and the author deserves all praise for the thorough and exhaustive work which he has done in searching the widely scattered records and combining the essentials of their contents into a clear and logical account of Portland cement manufacture.

A final section of five chapters discusses the puzzolan cements, of which slag cement stands first. Raw materials, manufacturing processes, and composition and properties are discussed in order, and there is a closing chapter on slag bricks and slag blocks.

Reviewing the book as a whole, it deserves to be mentioned that there are 165 illustrations, including diagrams, maps, views of quarries and mines, and drawings of machinery and buildings. There are 254 tables, giving commercial statistics and results of laboratory tests. A very valuable feature of each chapter is the elaborate bibliography of books and papers relating to the subject of that chapter. The publishers' work on the book is good, and there is a satisfactory index.

PHYSIKALISCH-CHEMISCHE BETRACHTUNGEN UBER DEN VERBRENNUNGS-PROZESS IN DEN GASMOTOREN.—By Professor Walter Nernst, University of Göttingen. Reprint of a Lecture delivered before the Verein Deutscher Ingenieure at Magdeburg, 1905. Berlin: Julius Springer. Paper; 5¾ x 8⅜ ins.; pp. 36; 5 illustrations in the text.

Professor Nernst's address, Physico-chemical Considerations on Combustion in Gas Engines, is suggestive and interesting as is always an address by a scientist to engineers. The lecture in question speaks first of the theoretical maximum efficiency of gas engines, and second of the rapidity and character of the flame-transmission. The latter is discussed by reference to the photographic studies of Dixon (Phil. Transactions, London, 1903) on the combustion of explosive mixtures in long tubes. A recognition of the facts which appear from these studies: the occurrence of slow combustion and of detonative explosion under different circumstances, and the change from the first to the second, is essential to full understanding of gas engine problems. The subject of the first portion of the address, theoretical combustion value, involves the tacit denial of a common assumption, the assumption that the combustion-heat of the reaction in the gas-engine cylinder is independent of the temperature at which the reaction takes place. Dissociation, increasing very rapidly as the temperature rises, affects the heat liberation. Hitherto exact numerical data for computing the coefficient of heat liberation have not been available in the past. Careful experimental researches made by the author on the actual dissociations, at various temperatures and pressures, during the formation of water and carbon dioxide now give us a close estimate of the coefficients. As computed in this address, the reduction from full heat value may amount to several per cent. of the total.

TYPHOID FEVER EPIDEMIC AT PALO ALTO, CALIFORNIA.—A Report Made to the Palo Alto Board of Health by J. C. L. Fish, Assoc. M. Am. Soc. C. E., President of the Board. Including an Analysis of Reported Cases by Clelia Duel Mosher, A. M., M. D., and Source of Infection of the Milk Supply by William Freeman Snow, A. M., M. D. Palo Alto, Cal.: The Board of Health. Paper; 6 x 9 ins.; pp. 62; 10 figures, partly in the text.

Professor Fish and his collaborators have produced an interesting and valuable study of a milk epidemic of typhoid fever accompanied by 286 cases and 12 deaths. The milk appears to have been infected with water from a creek polluted by the wastes from a house in which a number of cases of typhoid occurred, and a number of other cases originated. A number of the cases were on the grounds of Stanford University, which, although adjoining Palo Alto, are politically distinct from the town.

BACTERIOLOGICAL REPORT OF MUNICIPAL MECHANICAL FILTRATION PLANT AT DANVILLE, VIRGINIA.—By Ernest C. Levy, M. D., Sanitary Chemist and Bacteriologist, Director of Laboratory of City Water Department, Richmond, Virginia. Pittsburg, Pa.: Pittsburg Filter Mfg. Co. Paper; 6 x 9 ins.; pp. 7.

Bacterial tests of the Richmond filters were made during ten days in July and August, 1905. The results are here reported and discussed. A note on the tests was published on p. 327 of our issue of Sept. 28, 1905.

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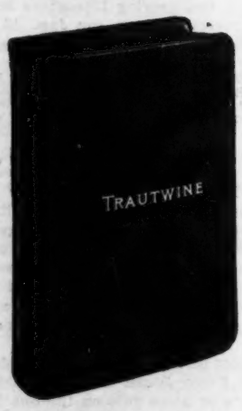

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Twelve Early Engineers.

LIVES OF THE ENGINEERS.—By Samuel Smiles, Author of "Character," "Self-Help," etc. In Five Volumes. London: John Murray. Cloth; 5 × 8 ins. 3s. 6d. each; American price, $1.40 each.
1: Vermuyden, Myddleton, Perry, James Brindley. Early Engineering. Pp. xxxv. × 380; six plates and 49 text figures.
2: Smeaton and Rennie. Harbours, Lighthouses, Bridges. Pp. 459; seven plates and 78 text figures.
3: Metcalfe and Telford. History of Roads. Pp. 412; seven plates and 68 text figures.
4: Boulton and Watt. The Steam Engine. Pp. 481; six plates and 61 text figures.
5: George and Robert Stephenson. The Locomotive. Pp. xliv. × 466; seven plates and 68 text figures.

A notable service has been rendered the engineering profession by bringing out this low-priced but well made and attractive illustrated edition of "Lives of the Engineers." The Lives first appeared some half century ago and thus need no introduction, except in so far as the younger engineers have never read them or as they have been forgotten by the older engineers. Of course, there is little danger of forgetting such names as Smeaton, Telford, Watt and the two Stephensons, but probably few persons who have not recently refreshed their memories could tell of the many activities of the several men outside of connecting each of them with some notable achievement, like Smeaton with the Eddystone lighthouse, Telford with road construction, Watt with the steam engine and the Stephensons with the locomotive.

The work of the earlier engineers was largely confined to canal construction, particularly in the cases of Vermuyden and Brindley. Sir Hugh Myddleton, who gave London its first copious water supply, really did it by means of a canal; hence the New River Co., founded by Myddleton nearly three hundred years ago, which has but recently, with numerous other companies, sold its works by order of Parliament to the London Metropolitan Water District. Harbors and lighthouses, and later on roads and bridges, were added to the tasks of the engineers, and gradually mill engineering was taken up.

Many of the achievements of these engineers were noteworthy simply because the men were pioneers, generally without the most ordinary tools or workmen suited to their needs. But the world will never cease to marvel at the difficulties and dangers overcome in building some of the early lighthouses and bridges, and at the ingenuity and persistence shown by the men who developed the first practicable steam engines and locomotives.

Metcalfe, the blind road and bridge builder, deserves special mention among the lesser characters portrayed in these volumes. Murdock, who introduced gas lighting, and who was one of the most capable and faithful of the lieutenants of Boulton and Watt, is another notable minor character, brought in from time to time in connection with Boulton and Watt.

Of the two men just named one might be puzzled to say which really deserves the most credit for developing the steam engine. Of course Watt can never be robbed of his glory as an inventor, but Boulton supplied the money, energy, courage and perseverance, without which the steam engine would have been much later, to say the least, in becoming a commercial success. Boulton was certainly one of the early, if not the earliest, captains of industry, showing great powers of organization and direction of men and machinery in not only the Soho engine works but also in his many other and varied industries.

To those who believe that an engineer should be a man of other associates than engineers and other attainments besides those of an engineering character, it is a pleasure to note that Telford was an intimate friend of poets and wrote no little poetry himself, some of which was of passable character. Both Watt and Boulton had wide acquaintance and intimate friendships with philosophers and men of letters. Telford, Watt and Boulton, as well as some of the other engineers whose lives are sketched in these volumes, obtained in one way or another as broad and deep scientific training as was possible in those days for men of their birth, station and great activities within their daily callings. Others of these engineers were greatly handicapped all their lives by their lack of even general education. This was most notable in the case of the elder Stephenson; notable both because of his comparative ignorance as a boy and young man and because of subsequent achievements, despite his poor start in life. Had George Stephenson enjoyed the early advantages of Watt his progress in developing the locomotive might perhaps have been more rapid, but it is by no means certain that his fame would be as great to-day, even had he made still further improvements in the locomotive.

In conclusion, it may be said that these Lives are full of interest, suggestion and stimulus for young and old alike. They are all the more valuable because they constitute so large a part of our meager stock of engineering biography. The hundreds of illustrations which they contain, most of them reproductions of artistic pen drawings of engineering works and their surroundings, are alone well worth the moderate price of the volumes.

LAS REDES ELECTRICAS.—Ensayo sobre una Teoria de la Distribucion de la Corriente Continua.—By Alejandro Guevara, Professor of Industrial Electricity at the Lima School of Engineers. Lima, Peru: Press of the School of Engineers. Paper; 6 × 8½ ins.; pp. 24; several line illustrations.

Ohm's law and the derived laws credited to Kirchhoff furnish a complete solution of all problems relating to the distribution of electric current in a network of conductors. Practically, such problems are hardly ever solved by exact computation except in the most simple case. Even in cases differing but slightly from the conventional groupings of a single electromotive force feeding a set of conductors in series, multiple or series-multiple, the available rules of calculation often fail to reduce the problem without risk of confusion. The author presents a new formula, or rather two formulas, as substitutes for Kirchhoff's laws in treating such problems: (1) Consider two points on a conductor, between which no branches leave that conductor; if A and B be the electric potentials at these points, referred to any zero-plane; if E be the amount of electromotive force inserted in the conductor between A and B; and if R be the resistance of the conductor between A and B, then

$$I = \frac{(A-B)+E}{R}$$

(2) In a conducting network, suppose M denotes one junction, and let all the adjoining junctions around M be marked A, B, C, etc.; let a, b, c, etc., be the resistance of the branches M A, M B, M C, etc.; and let α, β, γ, etc., be the sources of electromotive force which are contained in these branches. Then if, as before, we call M, A, B, etc., the potentials at the respective junctions, the following equation around M is true:

$$\Sigma\frac{M-A}{a}+\Sigma\frac{\alpha}{a}=0$$

These two laws are demonstrated and exemplified by the author. They appear to have distinct value in simplifying certain complex calculations of current distribution.

CLASSIFIED GUIDE TO TECHNICAL AND COMMERCIAL BOOKS.—A Subject-List of the Principal British and American Works in Print. Compiled by Edgar Greenwood. London: Scott, Greenwood & Co. New York: D. Van Nostrand Co. Cloth; 5½ × 8¼ ins.; pp. 216. $3, net.

In view of the fact that only American books to be found in stock in London are included in this volume, the number of American titles at first appears somewhat surprising. But when it is remembered that most of our leading publishers of technical books are in some way represented in London the surprise becomes less. A well-classified table of contents and an index greatly increase the usefulness of the book. The entries, it may be added, give title, author, publisher, price, size, illustrations and binding for the various books; also, what is sometimes of particular value, the date of publication, and, if a reissue, whether second, fifth, etc., edition.

SOILS AND FERTILIZERS.—By Harry Snyder, B. S., Professor of Agricultural Chemistry, University of Minnesota, and Chemist of the Minnesota Experiment Station. Second Edition. Easton, Pa.: The Chemical Publishing Co. Cloth; 5½ × 8 ins.; pp. 294; 40 figures in the text and one plate. $1.50.

Although a text book for students, this volume might be of use to any one interested in agriculture, and particularly to the rapidly increasing numbers of people in various walks of life who are daily yielding to a longing to "return to the soil." It is clearly written, with a marked absense of technicalities and with a sufficiency of practical examples to give interest and force to the discussion. The treatment is primarily from the chemical standpoint. Those wishing a broader treatment of the subject may supplement this volume with "The Soil," by Prof. F. H. King; "The Fertility of the Land," by Prof. I. P. Roberts. Some more distinctly and more detailed engineering aspects of the soil may be found in "Irrigation and Drainage," also by Professor King.

RAILWAY EQUIPMENT AND TRAFFIC.—Bulletin of American Railway Engineering and Maintenance of Way Association, Chicago. Secretary, L. C. Fritch, 1502 Monadnock Block. Paper; 17½ × 10¾ ins.; pp. 9.

This bulletin consists of a series of tables prepared by the Committee on Classification of Track, and showing for a number of individual railways and divisions, the weights and axle loads of engines and cars, the weight and speed of trains, the tonnage and car mileage, the number of tracks, and the percentage of different classes of freight traffic.

THE RED GUM.—By Alfred K. Chittenden and W. Kendrick Hatt. Bulletin 58, Bureau of Forestry, U. S. Department of Agriculture. Washington, D. C.: Pub Doc. Paper; 6 × 9 ins.; pp. 50; illustrated.

The red gum is found in the Gulf and Southeastern States, and has only recently been utilized commercially. Its growth, characteristics and uses are described by Mr. Chittenden, and Mr. Hatt deals with its mechanical properties.

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Literary Magazines.

"The New U. S. Naval Academy" is the subject of an excellent paper in the October "Century," but the paper which easily surpasses that in general interest is the relation by Gen. Horace Porter of the finding of the body of John Paul Jones. A more difficult piece of antiquarian research than that successfully accomplished by Gen. Porter in finding the long forgotten burial place of our great naval hero it would be difficult to conceive. We may only mention here that in the search of the area once occupied by the cemetery of St. Louis there were excavated 80 ft. of shafts and 800 ft. of galleries. Five leaden coffins were found in the search, one of which contained the body of John Paul Jones. A "Century" paper of large scientific interest, by Russell H. Chittenden, Director of the Sheffield Scientific School at Yale, summarizes the results of recent investigation of dietaries and nutrition, and shows that health and bodily vigor are entirely compatible with a much more sparing and economical diet than is commonly supposed.

Prof. Wm. Z. Ripley, of the Massachusetts Institute of Technology, has two notable articles in the October magazines dealing with the railway problem as it is now presented to the American people. One in the "Atlantic" is entitled "President Roosevelt's Railway Policy; Remedies." The other, in the "World's Work," is entitled "Great Changes in the Railroad Problem." Prof. Ripley is one of the best informed and mose careful of American economists, and the conclusion of his "World's Work" article is worth copying:

> A power too vast and arbitrary is loose among us. And there is but one remedy for the condition. Real efficient control and not sham supervision, by a Federal administrative commission is the need of the hour.

A second article in the "World's Work" describes the fight between the railways and the people that has been going on in Wisconsin, and makes plain some of the reasons why the demand for "a square deal" which President Roosevelt made has met with hearty approval throughout the West. The "North American Review" for October has also an article on railway rate-making, the author being Hon. Richard Olney.

THE ILLUSTRATED CARPENTER AND BUILDER.—Series of Technical Manuals. Edited by John Black. London, Eng.: John Dicks. New York: Industrial Publication Co. Stiff paper; 5 x 7¼ ins. 25 cts. each.

No. 2: Scaffolding. Pp. 90; illustrated.
No. 9: Concrete. Pp. 94; illustrated.
No. 13: Artificial Stone, etc. Pp. 92; illustrated.

The purpose of the publisher in presenting these little books deserves praise, but, at least in the three books before us, he has failed to reach the mark. All three of the books named are compilations worked up apparently from the information nearest at hand and with little attempt at logical arrangement or a discriminating selection of subject matter. For example, we have nearly a quarter of the book on "Scaffolding" taken up with a discussion and description of "ancient and mediaeval scaffolding," while the book on "Artificial Stone" devotes 30 of its 90 pages to mosaic work and less than five pages to concrete blocks, with no mention at all of brick and tile, but six pages on terra cotta. The American reader will find little in either of the three volumes to repay its purchase.

WATER SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.

No. 133: Report of Progress of Stream Measurements for the Calendar Year 1904. Prepared Under the Direction of F. H. Newell, by M. C. Hinderlider, G. L. Swendsen, and A. E. Chandler. Part X.—Colorado River and The Great Basin Drainage. Pp. 384; two plates and one text illustration.
No. 143: Experiments on Steel-Concrete Pipes on a Working Scale. By John H. Quinton. Pp. 61; four plates and four text illustrations.
No. 144: The Normal Distribution of Chlorine in the Natural Waters of New York and New England. By Daniel D. Jackson. Pp. 31; five folding plates.
No. 149: Preliminary List of Deep Borings in the United States. Second Edition, with Additions. By N. H. Darton. Pp. 175.

The contents of Papers 133 and 149 need no further mention.

Paper 143, by Mr. Quinton, details the methods and results of eight tests of reinforced concrete pipe, 5 ft. inside diameter, 20 ft. long and 6 ins. thick, and of a number of tests of similar pipe, 8 ins. in diameter and 18 ins. long, using different concrete mixtures. The general features of the tests of the larger pipe, together with a summary of conclusions, were given in an article by Mr. Quinton, published in Engineering News of March 9, 1905.

Paper 144, by Mr. Jackson, explains the important relation of chlorine to sanitary water analysis, describes briefly the methods employed in determining chlorine, outlines the history of normal chlorine work, and then discusses the isochlors of the seven states under consideration. There is a general isochloral map for New England and New York, and there are larger scale maps for Maine, for New Hampshire and Vermont, for Massachusetts, Rhode Island and Connecticut and for New York. The normal chlorines range from 6.0 parts per 1,000,000 on the Maine and Long Island coasts to 0.3 in northern Maine and well towards the western part of New York and 0.2 for the extreme westerly portion of New York.

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Publications Received.

ASSOCIATION OF OFFICIALS OF BUREAUS OF LABOR STATISTICS OF AMERICA.—Proceedings of the Twentieth Annual Convention, Held at Concord, N. H., July 12-16, 1904 (W. L. A. Johnson, Secretary, Topeka, Kan.). Paper; 6 x 9 ins.; pp. 122; one illustration.

DIE AUTOMATISCHE REGULIERUNG DER TURBINEN.—By Dr.-Ing. Walther Bauersfeld, Assistant in the Royal Technical High School at Berlin. Berlin, Germany: Julius Springer. Paper; 5⅝ x 8⅜ ins.; pp. 208; 126 figures, mostly in the text. 6 marks; American price, $2.40.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.

No. 256: Mineral Resources of the Elders Ridge Quadrangle, Pennsylvania. By Ralph W. Stone. Pp. 86; 12 plates (one in pocket) and four text illustrations.
No. 260: Paleontology of the Malone Jurassic Formation of Texas. By Francis Whittemore Cragin. With Stratigraphic Notes on Malone Mountain and the Surrounding Region near Sierra Blanca, Texas, by T. W. Stanton, Pp. 172; 29 plates.
No. 271: Bibliography and Index of North America Geology, Paleontology, Petrology and Mineralogy for the Year 1904. By Fred Boughton Weeks. Pp. 218.

ENGINEERING CHEMISTRY.—A Manual of Quantitative Chemical Analysis for the Use of Students, Chemists and Engineers. Third Edition. By Thomas B. Stillman, M. Sc., Ph. D., Professor of Analytical Chemistry in the Stevens Institute of Technology. Easton, Pa.: The Chemical Publishing Co. Cloth; 6 x 9 ins.; pp. 507; 139 figures, mostly in the text. $4.50.

GOVERNMENT REGULATION OF RAILWAY RATES.—A Study of the Experience of the United States, Germany, France, Austria-Hungary, Russia and Australia. By Hugo Richard Meyer, Assistant Professor of Political Economy in the University of Chicago. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5½ x 8 ins.; pp. xxvii + 486; one folding map. $1.50, net.

HANDBOOK OF COST DATA FOR CONTRACTORS AND ENGINEERS.—A Reference Book Giving Methods of Construction and Actual Costs of Materials and Labor on Numerous Engineering Works. By Halbert P. Gillette, Consulting Engineer, M. Am. Soc. C. E., M. Am. Inst. M. E., Late Associate Editor Engineering News. New York: Myron C. Clark. Morocco; 4¼ x 6¾ ins.; pp. 610; 30 figures in the text, and numerous tables. $4, net.

ON THE DISTRIBUTION OF GROWTHS IN SURFACE WATER-SUPPLIES AND ON THE METHOD OF COLLECTING SAMPLES FOR EXAMINATION.—By Frederick S. Hollis (New Haven, Conn.). Reprinted from Transactions of the American Microscopical Society, Vol. xxii. Paper; 6¼ x 9¾ ins.; pp. 49 to 62; four plates.

THE POLYTECHNIC ENGINEER.—The Annual Organ of the Engineering Society of the College of Arts and Engineering, Polytechnic Institute of Brooklyn (William J. Berry, Editor-in-Chief). Cloth; 7 x 10 ins.; pp. 138; illustrated.

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RESTRICTIVE RAILWAY LEGISLATION.—By Henry S. Haines, M. Am. Soc. C. E., M. Am. Soc. M. E., Ex-President American Railway Association, Author of "American Railway Management." New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5¼ x 8 ins.; pp. 355. $1.25, net.

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